EXPLORING THE NATURE OF TEACHERS' EXPERIENCES ABOUT THEIR BELIEFS, SUBJECT CONTENT KNOWLEDGE AND PROFESSIONAL DEVELOPMENT AND HOW THEY SHAPE CLASSROOM PRACTICES.

BY

THASMAI DHURUMRAJ

SUBMITTED IN ACCORDANCE WITH THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF EDUCATION – WITH SPECIALISATION IN CURRICULUM STUDIES

AT THE

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF AWELANI V MUDAU

NOVEMBER 2017

DECLARATION

STUDENT NUMBER: 4348- 616-9

I, *Thasmai Dhurumraj*, declare that "***Exploring the Nature of Teachers' Experiences about their Beliefs, Subject Content Knowledge and Professional Development and how they Shape Classroom Practices***", is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete citation and references. It has not been previously submitted for any degree, or examination at any other university.

SIGNATURE
T Dhurumraj

Nov 2017
DATE

TABLE OF CONTENTS

LIST OF APPENDICES

ACKNOWLEDGEMENTS

I wish to convey my sincere and heart-felt thanks to the following individuals who have assisted and supported me during my research:

Prof Awelani. V Mudau, my supervisor, who has guided, assisted and supported me throughout the study. I extend a special word of thanks to him for sharing his expertise so willingly and readily during the writing of this dissertation and for ensuring that the work was submitted in time;

A heartfelt gratitude to my loving parents, **Mr Bridgemohan Dhurumraj** and **Mrs Shakun Dhurumraj**, who have been my pillar of strength, encouraged me and taught me to always aim for the stars;

My siblings **Dr Vischal Dhurumraj** and **Ms Shobha Dhurumraj** for modelling patience to me always;

Dr Abel M. Mafukata for editing the document; and **Ms Z Ngcetane** for formatting my work;

Lastly I thank **The Almighty God** for the strength and wisdom **He** gave me to complete this study. In His matchless name, Amen.

ABSTRACT

The National Senior Certificate Diagnostic Reports for the 2014 and 2015 National Senior Certificate Examinations for the subject Physical Sciences reported that many candidates lacked understanding of basic concepts in the subject.

Most basic concepts are introduced and taught to learners as early as grade 10. Grade 10 provides learners with the foundation required to build a more intricate, and critical understanding of science. Critically, teachers have to drive this process. The nature of the experiences of the teachers would therefore be of primary influence during classroom practices to assist these learners. Teachers have to provide meaningful learning. Teacher experiences are derived from professional development, beliefs and subject content knowledge.

This was a qualitative study which made use of a case study design. It involved three cases from one of the districts of the Kwa-Zulu Natal Department of Education, South Africa. Data was collected using multimethod strategies and analysed using the typology approach.

This study was guided by the following main research questions: What are the nature of the experiences of teachers in implementing the Physical Science curriculum in a grade 10 class? The study sought to answer the following sub-questions, how does teacher knowledge influence classroom practice in the implementation of grade 10 Physical Sciences curriculum? What is the nature of the professional development received by the grade Physical Sciences teacher? and What are the teacher's beliefs with regard teaching and learning of Physical Sciences in a grade 10 class?

The findings of the study revealed that the *status quo* of traditional teaching of Physical Sciences still exists in the grade 10 classroom practices of teachers. Teacher generally displayed some good subject matter knowledge. A lack of professional development for grade 10 Physical Sciences teachers' negatively impacted on classroom practices of the teacher. Teacher beliefs had major influence on classroom practices of the teacher. This study recommends teachers have to undergo meaningful, ongoing professional development to assist them improve their classroom practice skills. A Model of Intensive Professional Development is recommended for teachers in the South African Classroom.

KEY WORDS AND TERMINOLOGY

- **Qualitative Study: T**he use of a naturalistic approach that seeks to understand phenomena in context-specific settings, whereby the researcher does not attempt to manipulate the phenomenon of interest (Golafshani, 2003).

- **Curriculum Implementation:** In this study it is defined as the teaching.

- **Inquiry Teaching:** The teaching of Physical Sciences through the use of activities (e.g. conducting experiments and analysing data collected, making inferences) that allow learners to be actively engaged in the learning process. Such activities should provide learners with the opportunity to develop knowledge and understanding of scientific skills.

- **Physical Sciences:** Physical Sciences investigate physical and chemical phenomena. This is done through scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the physical environment.

- **Pedagogical Content Knowledge:** The teacher's ability to effectively delivery subject matter knowledge through the use of varied teaching methodologies.

- **Teacher Context Knowledge:** Teacher understanding of their learning environment which includes factors such as resources availability and the Physical Science curriculum that impact on their classroom practices.

- **Teacher Beliefs:** Teacher's view based on the social constricts and contexts about teaching and learning Physical Sciences.

- **Professional Development:** The ongoing enhancement of Physical Sciences teachers in terms of their subject matter knowledge, practical knowledge and their pedagogical content knowledge.

- **Classroom Practice:** In this study it entails teacher knowledge, instructional strategies and discourse that a teacher uses in his/her classroom. This is based on the teacher's knowledge of the content, context and learners and his/her experiences in teaching Physical Sciences.

GLOSSARY OF ACRONYMS

ATP	**-**	Annual Teaching Plan
CAPS	**-**	Curriculum and Assessment Policy Statement
CPDF	**-**	Classroom Practice Diagnostic Framework
DBE	**-**	Department of Basic Education
DoE	**-**	Department of Education
ICPD	**-**	Intensive Care Professional Development
LoTL	**-**	Language of Teaching and Learning
NCS	**-**	National Curriculum Statement
NSC	**-**	National Senior Certificate
PCK	**-**	Pedagogical Content Knowledge
RNCS	**-**	Revised National Curriculum Statement
STEM	**-**	Science, Technology, Engineering and Maths
TCK	**-**	Teacher Content Knowledge
PPA	**-**	Prescribed Practical Activities
RPA	**-**	Recommended Practical Activities

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1. BACKGROUND

The 2014 and 2015 National Senior Certificate Diagnostic Reports drew some notable interest from broader society in South Africa. These reports revealed that a considerable number of learners studying Physical Sciences lacked understanding of basic concepts in the subject in some South African schools. These basic concepts are introduced to learners from the senior phase and enhanced later when the learners reach grade 10 (DBE, 2011). Assumptions are that these basic concepts provide the necessary foundation required of the learners to build a more intricate, and critical understanding of the Physical Sciences. The learners are expected to carry this baseline knowledge over the next level of their education; that is, to grade 11, and finally to grade 12. During this time, the learner would build on these ideas/models and thereby make sense of more complex concepts. Poor foundation on the basic concepts would have some negative impact on the progression of the learner in the subject of Physical Science. This assumption could be corroborated by the performance of South African learners who performed dismally poor during the Third International Mathematics and Science Study (TIMSS) held in 1995. There were 41 nations participating in these tests.

The performance of the South African learners was reported at 351 mean score even below international benchmark of 513 mean score (Makgato and Mji, 2006). Less than two percent of South African learners who participated in the tests were able to score above the international mean score (Makgato and Mji, 2006). Makgato and Mji (2006) went on to report that the performance of South African mathematics and Physical Science learners in grade 8 during the TIMSS-R tests held in 1999 was even far below international standards of the participant nations where South African learners scored a mean score of 275 against 487. The main factor influencing the poor performances has been low and poor standards in the teaching and learning of mathematics and Physical Sciences in most South African schools (Makgato and Mji, 2006).

Worrisomely, South African mathematics and Physical Science learners performed far lesser that learners from South Africa's economic counterparts of middle-income and developing economies such as Tunisia, Morocco, Chile, Indonesia, and Malaysia for example (Makgato and Mji, 2006). In addition, researchers (Dhurumraj, 2013; Kriek and Grayson, 2009) have also reported that over the past several years the number of learners who passed the subject of Physical Science in South African schools has been steadily decreasing. As a result the number of learners entering science programmes in universities has subsequently also declined. This puts into risk the goals of the National Development Plan (2012) which the post-apartheid government had thought to use in attracting more learners to study Science, Technology, Engineering and Maths (STEM) in South Africa. Other serious limitations in the teaching and learning of Physical Science in South Africa have been reported in the NSC Diagnostic reports of 2016, 2015 and 2014 respectively. These reports revealed that grade 10 Physical Science learners in most South African schools were:

- Unable to use a scientific calculator,
- Unable to convert to the correct units and solve equations,
- Unable to answer multiple step problems,
- Low in the understanding of the section of mechanics, and
- Had poor understanding of basic concepts such wavelength, frequency, potential difference and quantity of charge.

The NSC Diagnostic reports of 2016, 2015 and 2014, revealed that the majority of these learners lacked proper knowledge on practical work in the subject of Physical Science. Other recommendations from the NSC Diagnostic Report (2016, 2015, 2014) - especially as it regards grade 10 Chemistry section of Physical Science learners were that the scientific method and basics of science versus other ways of knowing needed to be inculcated in the learners. The argument was that these learners would improve their understanding on why such scientific methods were critical to aid their thinking abilities in relation to science learning. Also, the reports found that the learners were unable to understand Brackets Orders Division Multiplication Addition and Subtraction (BODMAS) calculations. The reports were critical of the fact that some topics were not taught, and therefore recommended that all the topics as prescribed by the CAPS should be completed. Further limitations were that some critical basic concepts on chemistry were not well defined and explained, and this needed to be rectified accordingly. Improved definitions on these concepts might aid the understanding of learners of these concepts, which for now, the understanding seems far too low and shallow. Finally, the reports indicated that basic stoichiometry seemed to be confined to some sections of the curriculum only to be developed using concrete models.

Based on the findings of the NSC Diagnostic reports of 2016, 2015 and 2014, this current study submits that there is a need to understand the dynamics in the teaching of Physical Sciences in grade 10 in South African schools. Therefore the focus of this study is to explore the experiences of teachers in the implementation of the Physical Sciences Curriculum in a grade ten class.

1.2. THE STATEMENT OF THE PROBLEM

Performance of learners in the Physical Sciences in most South African schools has been reportedly poor according to various stakeholders. One critical contributory factor to this poor performance in the subject has been identified as the lack of understanding of basic concepts amongst Physical Science learners despite the fact that these concepts are introduced as early as grade ten (DBE, 2016). While there has been some substantial growth in the number of studies and academic literature focusing on the teaching and learning of Physical Science in South African schools post-apartheid in particular, studies and academic literature on the teaching and learning of Physical Science particularly in grade 10 has been conspicuously absent. Having looked at the critical importance of this grade in the context of the South African education system, a study which particularises its discourse on this grade is crucial. Consequently, this study fills that gap. However, the study is mindful of the fact that it is practically difficult if not impossible to study everything on grade 10 teaching and learning in Physical Science in South African schools because of obvious limitations. This study therefore chose to focus on the exploration of teacher experiences in the implementation of the grade 10 Physical Sciences curriculum in South African schools. This study premises that it is the teachers' experiences in the implementation of this curriculum which shape classroom practice in the subject. These experiences might be informed by, amongst others: teacher knowledge, teacher's beliefs in the teaching and learning of Physical Science, and in addition, the professional development of the teacher. This study was guided by a structured aim and a set of objectives which it needed to achieve. These are briefly explained here-under.

1.3. THE MAIN AIM OF THE STUDY

The main aim of this study is to explore the experiences of teachers in the implementation of Physical Sciences curriculum in a grade 10 class.

1.4. RESEARCH OBJECTIVES

The objectives of this study are to:

- Explore how the teacher’s knowledge influences classroom practice in the quest of implementing the requirements of the curriculum in a grade 10 class in Physical Sciences,
- Establish the teacher’s experiences on the professional development they have received in their training, and

- Understand how the teacher's personal belief in the teaching and learning of Physical Sciences influences classroom practice when implementing the requirements of a grade 10 class Physical Sciences curriculum.

1.5 RESEARCH QUESTIONS

In order to address the research's main aim, this study answers the question:

- What are the experiences of teachers in the implementation of the Physical Sciences curriculum in a grade 10 class?

In addressing the research's objectives, the following sub-questions were critical to answer:

- How does teacher knowledge influence classroom practice in the implementation of grade 10 Physical Sciences curriculum?

- What is the nature of the professional development received by the grade 10 Physical Sciences teacher?

- What are the teacher's beliefs with regard teaching and learning of Physical Sciences in a grade 10 class?

1.6 SIGNIFICANCE OF THE STUDY

This research study should contribute to the body of knowledge on the teaching of grade 10 Physical Sciences in South African schools, and elsewhere the educational set-up and context that could be similar. Various stakeholders such as curriculum programme developers for example should benefit from the findings of this study from which they could gain valuable knowledge on, for example, designing of in-service training and development workshops for teachers in the implementation of the curriculum in grade 10 Physical Sciences. This knowledge might resultantly assist teachers to improve learner understanding of basic concepts in the Physical Sciences which they seem to be currently battling with.

1.7 METHODOLOGY FOR THE STUDY

Due to the nature of this study being descriptive and exploratory, a qualitative case research design was adopted. The rationale for the use of a case study was that it allowed the researcher to explore in-depth experiences of teachers in the teaching of Physical Sciences in grade 10 classrooms. This study was conducted in one of the selected districts in Kwa-Zulu Natal, South Africa. To ensure rigour, all data collection instruments were piloted. Some observations were also conducted in some participant schools in the district. Data were collected through teacher interviews, observations and questionnaires. Data were recorded as field notes for analysis. Data were analysed using the typology approach.

1.8 DELIMITATIONS AND LIMITATIONS OF THE STUDY

This study examines the experiences of teachers with special focus on the implementation of grade 10 Physical Science curriculum in South African schools. Three participants were drawn from one of the districts in Kwa-Zulu Natal. The focus of this study was on teacher knowledge, teacher beliefs in the teaching and learning of Physical Science in a grade 10 class and the professional development of the teacher. The limitations of this study were that very few participant schools were selected (n=3), and these schools were in addition selected from only one district of the entire Kwa-Zulu Natal Province. This study therefore lacks in representativity of the entire population of teachers and schools in other education districts of Kwa-Zulu Natal. However valid and reliable inferences can still be drawn from the experiences gained from these selected cases.

1.9 STRUCTURE OF THE THESIS

This section gives a brief description of the contents of each chapter in this study. The chapters are structured as follows:

Chapter 1 – Background to the Study

This chapter provides the introduction and background information to the study. The chapter introduces the study, describes the problem statement of the study, and discusses the study aim; objectives and limitations while it closes by outlining the rest of the chapters in the study.

Chapter 2 – Literature Review

This chapter presents the theoretical background of the study. Factors influencing the classroom discourse and instructional strategies used by teachers in the implementation of Physical Science curriculum are explored, elaborated on and presented here. The requirements for implementation of a science curriculum in a post-apartheid South African classroom are also presented in this chapter.

Chapter 3 – The Conceptual Framework

This chapter explains the conceptual framework as well as its application to this study.

Chapter 4 – Research Methodology and Design

In this chapter the design and methods used for data collection and analyses are explained in detail. The procedures used in the collection techniques, and coding processes of the data are also presented.

Chapter 5 – Data Analysis, Interpretation and Findings

The findings of the research are presented and discussed in this chapter.

Chapter 6 – Final Conclusions and Future Recommendations

Based on the data analysis and literature reviewed for the purpose of this paper, final conclusions drawn emanating from the study are made. In addition, the chapter presents policy recommendations for each finding emanating from this study.

1.10. CHAPTER CONCLUSION

This chapter presents the background and overview of this study. Included in this chapter is the statement of the problem, the study aim and objectives, the methodology used in the study, and a brief narrative on the significance of this study in relation to the field of study. Demarcation of the field of study together with the limitations of the study are also indicated in this chapter. Finally, the structure of the study is briefly outlined. While the current chapter delved in the introduction and background of this study, the next chapter focuses on the review of the literature used for the purpose of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 PRELUDE

This chapter presents the literature reviewed for the purpose of this study. Physical Sciences (which includes Physics and Chemistry) has been found to pose fundamental challenges for both teachers and learners in South African schools. At this point, teacher understanding of the curriculum and its delivery in class become critically important. By exploring the experiences of the teacher this study sought to determine the types of decisions made by teachers with regards to classroom practice in Physical Science for grade 10. In addition, the factors influencing teacher decision making processes during delivery of the prescribed curriculum also receive attention. Henceforth the words Physical Sciences and Sciences are interchangeably used in this study.

General performance amongst Physical Science learners in most South African schools has been reportedly decreasing as far back as 2013 as reported by the 2014 and 2015 National Senior Certificate Diagnostic Report for the National Senior Certificate Examination (NCS). The National Examination under CAPS was first written in 2014. Candidates showed a drop in performance in the subject as shown on Table 1 below:

Table 1: Overall achievement in Physical Science 2011 - 2015

Year	No Wrote	No. achieved at 30% and above	Percentage achieved at 30% and above	No achieved at 40% and above	Percentage achieved at 40% and above
2011	180585	96 441	53.4	61 109	33.8
2012	179194	109918	61.3	70 076	39.1
2013	184383	124206	67.4	78 677	42.7
2014	167997	103348	61.5	62 032	36.9
2015	193189	113121	58.6	9 6999	36.1

Source: (Adapted from NSC Diagnostic Report 2015 and 2011)

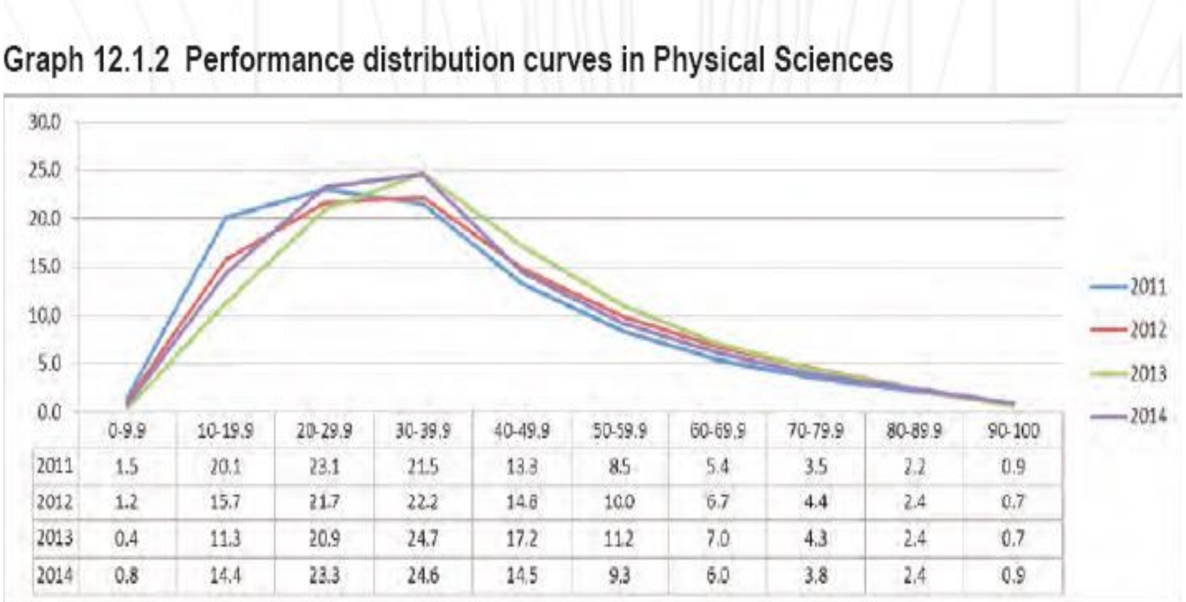
- The number of candidates that passed the examinations at the 30 percent level had decreased by 5.9 percentage points.
- The number of candidates that passed the examinations at the 40 percent level decreased by 5.8 percentage points.

In the 2015 National Senior Certificate examinations, although the number of candidates for this examination had increased, the general performance levels of the candidates still decreased yet again. Number of passes at the 30 percent level decreased by a further 2.9 percent (DBE, 2015). The number of passes at the 40 percent level decreased by a further 0.8 percent. Schools in South Africa write a National Examination for Physical Sciences as well as in mathematics (DBE, 2015).

According to Table 1 above, there had been a tremendous decrease in the number of learners who have registered for Physical Science at the FET phase between 2013 and 2014. As Trumper (2006) points out that there has been a decline in learner enrolment in the sciences in the secondary school phase. Learners were reluctant to take Physical Science as a subject. This tendency is expected to have implacable consequences on the targets of national education imperatives in South Africa.

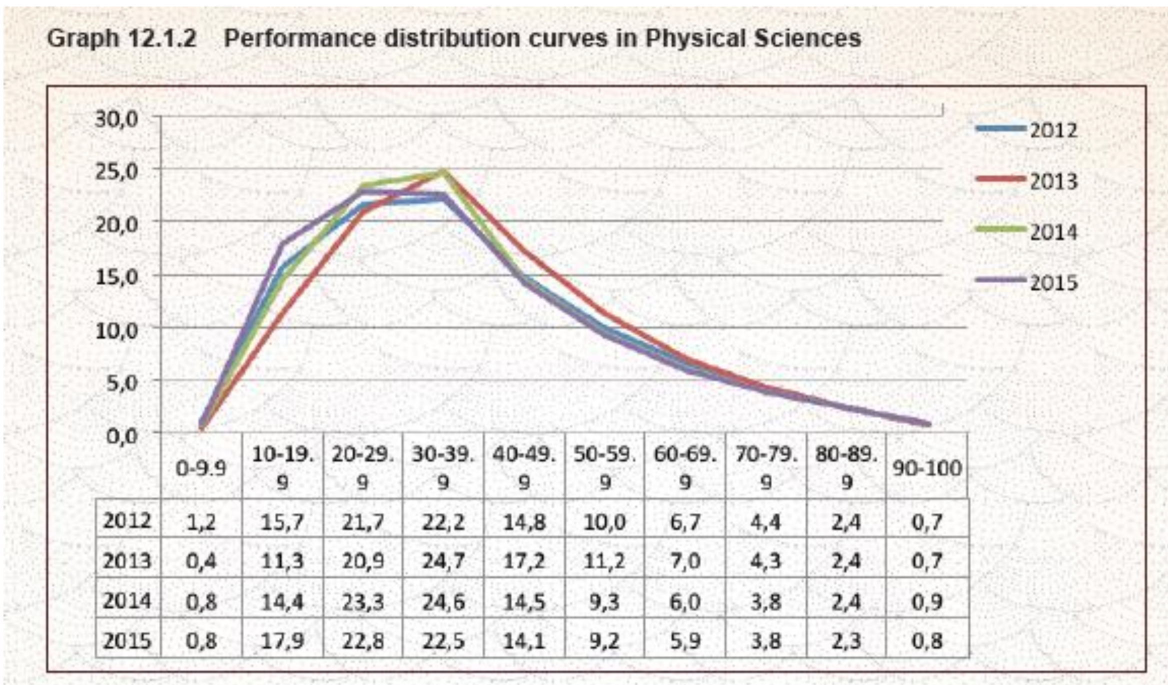
Second to be affected is the national desire to build a post-apartheid South Africa which is self-sufficient in science and technology expertise amongst its citizenry unlike the current situation where the country is outsourcing such skills from other countries. It is imperative to have an effective science curriculum throughout the formal education bend which would assist South Africa's target of building an economy based on science and technology capabilities of the citizenry. However, there has been some slight increases of learner enrolments in 2015 academic year. This could have been triggered by increases of repeat learner enrolments in the sciences particularly in the private schooling band.

According to the Performance Distribution Curves (Figure 1 and Figure 2), below, the number of learners that achieved between 0-29 percent increase in 2014, this implies an overall drop in the performance of learners who wrote Physical Science; whilst in 2015 the number that achieved between 20-29.9 percent had decreased while the number of candidates who achieved between 10-19.9 percent had increased by 3.5 percent. Although there has been increases in performance in 2013, the Department of Basic Education, notes however that there has been a “disappointing decline in performance over the past two years (2013 and 2014) ” (DBE, 2015, p. 176).



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2011	1.5	20.1	23.1	21.5	13.3	8.5	5.4	3.5	2.2	0.9
2012	1.2	15.7	21.7	22.2	14.6	10.0	6.7	4.4	2.4	0.7
2013	0.4	11.3	20.9	24.7	17.2	11.2	7.0	4.3	2.4	0.7
2014	0.8	14.4	23.3	24.6	14.5	9.3	6.0	3.8	2.4	0.9

Figure 1: Performance Distribution Curves in Physical Sciences 2011-2014
Source: (NSC Diagnostic Report, 2015).



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2012	1,2	15,7	21,7	22,2	14,8	10,0	6,7	4,4	2,4	0,7
2013	0,4	11,3	20,9	24,7	17,2	11,2	7,0	4,3	2,4	0,7
2014	0,8	14,4	23,3	24,6	14,5	9,3	6,0	3,8	2,4	0,9
2015	0,8	17,9	22,8	22,5	14,1	9,2	5,9	3,8	2,3	0,8

Figure 2: Performance Distribution Curves in Physical Sciences 2012-2015
Source: (NSC Diagnostic Report, 2015)

Essentially this study however focuses its discourse on the CAPS. The concerning factor is that since its introduction the results for the National Senior Certificate examinations have shown little to no improvement.

2.2 THE PHYSICAL SCIENCES CURRICULUM IN SOUTH AFRICA

Ramnarain (2014) reports that the revised South African school Physical Sciences curriculum advocated for an inquiry-based approach to learning. This is to encourage learners to discover various objects, situations and events in their immediate environment, and in addition to collect data and record information and based on their findings draw accurate conclusions (DoE, 2003).

Prescribed Practical Activities (PPA) and Recommended Practical Activities (RPA) have been introduced as part of the refinement of the NCS for Physical Sciences; and the CAPS curriculum has replaced learning outcomes with content standards (Dudu, 2017). Ramnarain (2014), further points this imperative is also expressed in the CAPS document. CAPS states that Physical Sciences is a subject that "promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships" (DBE, 2011, p. 8). Dudu (2017), further stresses that the CAPS curriculum requires learners to have active participation in the prescribed areas of learning and in addition recommended practical activities for the learners.

The aims of Physical Sciences in RSA are as follows (DBE, 2011):

- To make learners aware of their environment and equip them with investigating skills e.g. hypothesising, observing, predicting, problem-solving, inferring etc.
- Promotion of knowledge and skills in the scientific inquiry and problem-solving.
- Construction and application of scientific and technological knowledge.
- Understanding the nature of science and its relationship to technology, society and the environment.
- Preparing learners for future learning, employment and specialisation of learning areas, holistic development etc.

The Curriculum for Physical Science

The curriculum for Physical Science consists of six main knowledge areas for grade 10 to 12 learners; they are:

- Physics
- Mechanics
- Waves, Sound and Light
- Electricity and Magnetism

Chemistry

- Chemical Change
- Chemical Systems
- Matter and Materials

Physical Science has been awarded four hours of teaching time per week with a total of forty weeks (Appendix 1 - Table 1a). This allocated time includes the teaching of content, skills, content as well practical work. The Department of Basic Education (2011), stresses the importance of the integration of practicals with theory. The department stipulates and prescribes formal practical assessments and recommended informal assessments that should be conducted with the learners. This will allow for learners to develop a holistic view and better understanding of concepts being taught. An overview given by the DBE (2011) of the content to be covered is given in Appendix 1 (Table 1b).

To ensure standardization across the board, the CAPS document clearly stipulates the conditions under which tests and examinations in Physical Sciences should be set. The control tests and examinations for Physical Sciences assess the performance of learners at different cognitive levels with an emphasis on the following (DBE, 2011):

- Process skills,
- Critical thinking,
- Scientific reasoning, and
- Strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts.

Examinations papers and control tests in the Physical Sciences in grades 10-12 would adhere to the weighting of cognitive levels (Appendix A –Table 1c & Table 1d); seventy five percent of a Physical Science test or examination consists of a combination of level two (comprehension questions) and level three (application questions) type questions. In paper one, level three type questions which consist of analysis and application type questions, requires a higher order of learner thinking.

The teacher is required to develop the skills in the learner in order for the learner to succeed in an examination. Grussendorff, Booyse and Burroughs (2014) reports that CAPS places greater emphasis on controlled tests and exams, and there is a de-emphasis of continuous assessment. In paper two, level two type questions which build around comprehension type questions takes the substantial amount of the paper.

Thus intellectual capacity of learners who choose Physical Science as a core subject needs to be developed as early as grade 10. This is to allow for progression from grade 10 to grade 12 for these learners. As Grussendorff (2014) stated, CAPS maintains (as in the RNCS) that the curricula is based on a high level of skills, knowledge and progression of concepts / skills from simple to complex. This is evident in the section of Acid and Bases under the heading Chemical Change. The researcher shows the degree of progression in tabular form for the above section (appendix 22).

2.3 TEACHING PHYSICAL SCIENCES

Teaching is a profession that involves special forms of knowledge and skill (Bullough, 2001). In the South African context, the shift from the traditional content-driven curriculum to one that is more learner-driven and inquiry-based has in no doubt affected teacher's practice. Therefore with the introduction of Outcomes Based education (OBE) and curriculum reform, teachers had to also reform their pedagogical content knowledge frameworks in order to develop the required scientific skills and knowledge in learners as stipulated by the National Department of Education. Thus, assessment or teaching in Physical Sciences is greatly influenced by the human resource, i.e. sufficiently trained Physical Science teachers should be effective in teaching the subject and assessing learner performance both adequately and appropriately (Mchunu, 2009).

The quality of the Physical Science teacher is often questioned when learner performance drops. This de-motivating question for many teachers teaching Physical Sciences has not only occurred in the South African Education system but has been a common occurrence since the early 1980's in the United States as well, where the quality of teachers (including those teaching Physical Sciences) produced from the teacher education programmes were under frequent attacks by politicians and policy makers (Park, Jang, Chen, and Jung, 2011).

Physical Science teachers who are knowledgeable about the nature of Science and Physical Sciences play a central role in promoting functional scientific literacy in society (Ramnarain, 2013). Physical Science teachers make use of multiple pedagogical strategies to transform their existing knowledge of the subject content into a form that can be easily understood by learners. Shulman (1996) named this 'pedagogical content knowledge'. Therefore the Pedagogical Content Knowledge (PCK) of the teacher, will ultimately influence the classroom practices of the teacher. Ultimately it is the nature of the teacher's science knowledge, which effects the progressive cognitive development of a Physical Science learner. Therefore the Physical Science teacher has to be well grounded in his/her knowledge in order for meaningful teaching and learning to take place amongst learners (Ramnarain, 2013).

The classroom practices of the Physical Science teacher is vital to the teaching process. According to Chilembe and Bruce (2015), classroom practices that teachers adopt must assist learners to maximise their full potential during the learning processes. Therefore teachers are urged to make use of a variety of teaching methodologies in their classroom in order to accommodate a variety of learning styles as it allows for the attainment of cross-cutting core competences (Chilembe and Bruce, 2015).

In the South African classroom teaching Physical Sciences through the use of various classroom practices (which includes adopting different styles of teaching) can be of tremendous benefit for teachers particularly when faced with hindrances such as resource availability, and large class sizes (Banning, 2005). Five teaching styles that prevail in the classroom has been identified by Grasha (2002) as follows:

- The expert teaching style,
- The formal authority teaching style,
- The personal model teaching style,
- The facilitator teaching style, and
- The delegator teaching style.

Chilembe and Bruce (2015), explain each of the teaching styles identified by Grasha (2002) as follows:

- *The Expert Teaching Style:* this type of style portrays the teacher as the expert, and providing learners with an extensive amount of detailed knowledge leaving little room for the development of learners own reasoning and thinking ability.

- *The Formal Authority Teaching Style:* in this style the teacher is given a particular status due to his/her authority and knowledge. Learners know that which is expected of them and tend to focus of acceptable ways of practice.

- *The Personal Model Teaching Style:* the emphasis on this model is direct observation. The role of the teacher is to oversee learners and guide and direct them by showing them the example to follow.

- *The Facilitator Teaching Style:* in this approach the teacher acts as a mediator of learning. This approach is more learner-centred and encourages inquiry based learning. When using this style of teaching an important point to note is that teachers have to be competent in their knowledge base, possess self-esteem and be flexible with their methods of teaching.

- *The Delegator Teaching Style:* this style encourages learner initiative and responsibility. The teacher acts as a resource for knowledge and encourages more small group discussions and individual projects. The goal of this style is to develop autonomous learners; however the maturity of the learner must be taken into account.

Chilembe and Bruce (2015) reiterate that no one style is better than the other rather a combination of these styles should be used during classroom practice. This will enhance deep learning (Grasha, 2002) and active learning. Ironside (2003) states that when a teacher makes use of a variety of teaching styles, it automatically promotes a variety of learning styles to be fostered thereby empowering learners and engaging them with the learning process. This aspect then promotes the development of critical thinking in learners, problem-solving skills, and decision-making (Chilembe and Bruce, 2015).

In the Physical Science classroom this study posits that the teacher plays an important role as a mediator or facilitator of learning. The teacher presents the learners with content (by means of case studies or activities on worksheets). While doing so, the teacher employs an analytical approach which acknowledges the importance of interactions and student-teacher discourse in the classroom develops (She, 2000). According to Wenglinsky (2002), to have the academic performance of learners improved regardless of their backgrounds, three types of classroom practices should be employed by the teacher during classroom practice:

- Individualisation,
- Collaboration, and
- Authentic assessment.

Wenglinsky (2002) further describes each practice as follows:

- *Individualization:* the instruction given to each learner by the teacher differs based on the knowledge and experience the learner already possesses.

- *Collaborative learning:* during this process, the teacher allows the learners to work together in groups. The scaffolding of knowledge through the process of constructivism is reinforced in this type learning.

- *Authentic assessment:* the assessment occurs as an artefact of the learning activity.

The level of knowledge that a learner brings into the classroom is irrelevant. Wenglinsky's (2002) posits that the classroom practices of the teacher that can either enhance the teaching and learning process or create a major obstacle to learners' learning. There is no single approach that can be used in the teaching of Physical Science. This current study posits that in order for meaningful learning to take place the teacher must be knowledgeable of the various approaches to teaching Physical Sciences.

2.4 EMPIRICAL STUDIES ON SCIENCE TEACHING

Empirical studies on science teaching have indicated that the extensive use of analogies during delivery of a lesson is of great value towards achieving meaningful learning (Duit, 1991). Analogies in learning facilitate the visualization of an abstract domain, as in the case of science (Duit, 1991). However, it has been reported that science teachers do not seem to have a repertoire of good analogies. This is because the majority of the teachers were still clinging on non-effective traditional views of the learning process in Physical Science. In addition, these teachers often lacked personal confidence with regard effective use of analogies (Duit, 1991).

Lawson, Abraham and Renner (1989), state that the learning of science is best achieved through the process of discovery, during which the teacher introduces a new concept to the learners in a manner that allows the learners' prior knowledge to be interpreted using the introduced concept. Thereafter the teacher could follow the introduction with opportunities for the learners to discover that new observations could be interpreted using the concept. Thus the researcher posits that for the teaching and learning of science, declarative knowledge and procedural knowledge are essential for meaningful learning to take place in the classroom. Anderson (1980, p. 222) states in fact thus "declarative knowledge comprises the facts that we know; procedural knowledge comprises the skills we know how to perform".

Teacher's beliefs of teaching and learning science often have a pervasive influence on their classroom practices (van Driel, Verloop, and de Vos, 1998). Existing literature on teachers' conceptions of teaching and learning science has found that experienced science teachers had developed their own conceptual frameworks and their teaching practices seemed to be consistent with these developed frameworks (Brickhouse, 1990). The framework that these experienced teachers developed include knowledge and beliefs about science, subject matter, teaching and learning, and learners that were all interrelated in a coherent manner (Brickhouse, 1990). Brickhouse, and Bodner (1992) revealed that novice teachers tended to experience conflicts between their personal views of science and science teaching on the one hand and their personal classroom practice on the other.

When teachers have extensive years of experience in teaching the same subject and following the same curriculum, there is no doubt their knowledge of the content is improved - sometimes to attain excellence. South Africa was recently ranked by the World Economic Forum at 137th out of 139 countries in mathematics and science education (Heeralal and Dhurumraj, 2016). Poor teacher education has been cited as being one major contributory factor to the dismal state of affairs in science education in South Africa. The poor state of teachers' content knowledge in the sciences in particular has been cited as a major complexity contributing to the state of affairs in the sciences in South African schools (Heeralal and Dhurumraj, 2016).

It is the years of experience in a classroom and familiarity with the subject content that positively contribute to the teacher's pedagogical content knowledge (PCK)[1] (van Driel, Verloop, and de Vos, 1998). When teachers spend a number of years in the classroom they develop general pedagogical knowledge, which creates a supporting framework for the development of PCK (van Driel, Verloop, and de Vos, 1998). van Driel et al. (1998) verified that during peer interaction and discussions amongst teacher colleagues, teachers might draw attention to occurrences of specific learning difficulties and misconceptions as observed amongst their learners. Sharing of information allows for conceptual change and promotes the development of pedagogical knowledge amongst teachers. Proper teacher support becomes fundamentally crucial and essential. Kleinman (1965) corroborates this assertion. Kleinman (1965) contended that teachers who asked more critical thinking questions during classroom practice imparted a better understanding of scientific concepts to their learners. These teachers improved learner science abilities. Contrary however, teachers who maintained the basic level of questioning have often failed to improve learner performance in their subjects.

2.5 EXPLAINING THE INTERRELATIONSHIP BETWEEN TEACHER BELIEFS ON TEACHING AND LEARNING

"Beliefs are the best indicators of the decisions individuals make throughout their lives" (Pajares, 1992, p. 308). Bandura (1997), further describes beliefs as pre-eminent indicators of the decisions people took throughout their lives. It is argued by many that the beliefs of teachers' influences their views of teaching during classroom practice (Pajares, 1992). According to Lumpe, Haney, and Czerniak (2000), policy reports set forth the goal of scientific literacy however the onerous tasks of implementation falls upon the teacher and it is essential to take cognisance of the teacher's beliefs about teaching. The beliefs of teachers must not be ignored if the recommendations of policy are to result in enduring change in the classroom (Lumpe et al., 2000).

Oliver and Koballa (1992) are of the view that teacher beliefs are associated with knowledge, attitudes, and personal convictions, or are reflective of one's

[1] Pedagogical Content Knowledge – when subject matter knowledge is taken and transformed in a manner that can effectively be communicated to learners (van Driel, Verloop, and de Vos, 1998).

acceptance or rejection of a proposition. However Lumpe et al. (2000, p. 276), states “beliefs are often confused with other related concepts such as attitudes, values, judgements, concepts, and dispositions.” The belief of an individual influences their life and actions, and as a result the beliefs of science teachers also play a role in restricting science education (Lumpe et al*.,* 2000).

The alternation of belief of a teacher can be very difficult to achieve (Earley and Bubb, 2004). Teachers will only take ownership if they are involved in and committed to the process of educational change. However, some teachers are firmly rooted in their personal beliefs. Although it is easy to teach teachers new teaching approaches but to change ones belief is not an easy task. Beliefs just are difficult to change overnight. According to Morgan and Xu (2011), teachers' beliefs about teaching and learning are often identified as an obstacle to the successful implementation of curriculum reform. Many teachers have agreed that a teacher beliefs may, in some way, affect their classroom practice (Tsai, 2002).

In the South African education system, research has revealed that although a change in curriculum was announced in the post-apartheid era, many teachers still continued with existing traditional teaching practices, with a little tweaking to show that they had modified their teaching to the required style. The momentum of educational transformation is therefore seriously slowed down. Teacher beliefs are very difficult to change for two reasons:

- The change process is very slow and teachers are often over-worked (Lotter, Harwood, and Bonner, 2007).
- The experiences are developed over years of experience from teaching in the classroom.

Teachers Beliefs on Classroom Practice

Existing research studies have revealed that teachers' epistemological views of science influences how science is conducted and portrayed in a teacher's classroom (Lederman, 1992). Lederman (1992), further state that the teachers' scientific epistemological views are often consistent with their instructional beliefs and practice. Teachers form and develop classroom practice theories based on personal experiences gained in their classroom practices over the years (Lotter et al., 2007). However, it is also possible of teachers to form and develop classroom practice theories during the period of being learners. In other words, what the teachers would observe as learners might be transcribed into view points of how classroom teaching should be when such learners become teachers themselves. According to Calderhead and Robson (1991), when teachers go through the pre-service training some hold onto vivid images of teaching from their experiences as learners; and these images have in turn affected learners' interpretations of course experiences and strongly influenced the translated knowledge and projected practices they would apply as teachers.

Teachers' classroom practices grow with experience and time. With this the teacher's knowledge expands and becomes more coherent and as a result a highly personalized pedagogy or belief system is developed that actually controls the teacher's perception, judgement, and behaviour (Mansour, 2008). It is further noted that to change the beliefs of a pre-service teacher is far easier than that of an experienced teacher (Tschannen-Moran, Woolfolk Hoy, and Hoy, 1998).

According to Lotter et al. (2007), teachers who believed in a “hypothetico-deductive philosophy of logical positivism” taught science as a collection of facts. Thus the use of scientific processes skills was very limited in such teachers' classroom practices. The traditional belief is very similar to what Lotter et al. (2007) described above. According to Tsai (2002), teachers who use the traditional category taught science by merely transferring knowledge from teacher to learner. These teachers become "experts" of the content knowledge which they pass on to the "object" learner as complete scientific facts, firm and accurate to a point of needing no interrogation. The learner is a passive recipient of knowledge. Laplante (1997), posits that teachers' epistemologies are passed onto learners as their own with some teachers believing that “school science” is separate from “real science”. With this approach in mind, the teacher's focus is therefore more on the mechanical delivery of the curriculum. Resultantly, these kind of teachers would normally adopt traditional approaches in their classroom practices than innovative practices characterising new approaches in modern classroom practice in Physical Science. The next section of this sub-section discusses briefly one of the popular theories in the teaching of Physical Science; the Constructivist theory.

The Constructivist Theory

The constructivist theory is based on learning that occurs through personal experience. In Constructivism, learners are actively engaged in an activity drawn from previous knowledge. From this knowledge, learners build and construct new meanings. Thus, the knowledge that all individuals possess is a function of their experiences and beliefs (Jonassen, 1991). Geer and Rudge (2002), further describe constructivism as a theory of learning whereby learners construct knowledge in the process of learning through social interaction and active participation with phenomena, as they develop shared meanings on that phenomena. Alonso, Lopez, Manrique, and Vines (2005), contend that constructivism builds on behaviour and cognition by taking multiple perspectives and maintaining that learning and its interpretations depend on attachment to constructivism. Constructivism allows the instruction for learning to take on a more branched design rather a linear format (Alonso et al., 2005). Using this approach in classroom practice in Physical Sciences allows for “major paradigm shift” in the subject (Mchunu, 2012, p. 106).

The Physical Science teacher is now a mediator of learning during classroom practice. Imende (2005) explains that which was previously the responsibility of the teacher (researching information, collecting and collaborating) now become the responsibility of the learner. The learner is exposed to taking responsibility for learning. When the teacher uses this type of approach in teaching there is no room for the learner to display laziness because the learner is actively involved in the learning process (Imende, 2005). The learner becomes the primary focus while the teacher’s delivery of content becomes secondary. Fosnot (1996) highlights that teachers are encouraged to apply constructivist teaching approaches to their pedagogy by asking questions, and scaffolding of the learners’ learning. Thus learning is not an individualistic process it is social, it is the result of the individuals historical, social and cultural experiences as postulated by Lev Vygotsky's Socio-cultural Theory in learning (Gibbons, 2002).

The constructivist teaching sequence has been summarised into four principles by Gray (1997):

- Learning depends on prior knowledge of the learner.
- Changing and adapting old ideas creates new ideas.
- Learning is inventing new ideas rather than mechanical accumulation of facts.
- Meaningful learning occurs through rethinking old ideas and coming to new conclusions because of conflicts with the old ideas in the light of emerging evidence.

Mudau (2013) theorises that constructivist theories might be personal, social, radical, contextual and critical. Constructivism can be categorised into two broad bands; namely the constructivist theories of teaching and learning and those that are based on socio-cultural learning (Leach and Scott, 2003). Constructivist theories of teaching and learning and also focus on cognitive developmental level of the individual while the sociocultural takes both the individual view as well as the social environment of the learner into account (Mudau, 2013). Based on these theorisations, Mudau (2013) argues that learning therefore takes place in a social environment and in the mental structure of the individual.

Radical constructivism and social constructivism are two angles of the constructivist theory. Both these constructs are relevant to learning and instruction in science practice (Reddy, Ankiewicz, and De Swardt, 2005). People acquire knowledge by making sense of the world they live in i.e. the knowledge is viable to the individual. According to Reddy et al. (2005), any individual can be an autonomous learner. From the radical constructivism approach comes the question of reflection and choice on the part of the learner, however within certain prescribed confinements (Mchunu, 2012).

Mchunu (2012) further states that the radical constructivism approach to learning impacts on the teaching of Physical Sciences, in terms of providing opportunity for learners to act independently and reflect on their learning. Physical Sciences focus on developing learners to be able to investigate physical and chemical phenomena through scientific inquiry and the application of scientific theories, models and laws to explain and predict events in the physical environment (DoE, 2003). Radical constructivist approach as described by Mchunu (2012) provides each individual learner with the chance to experience knowledge construction through the process of creative and critical thinking, problem solving, and decision making for example.

According to Looi, Sun, and Xie (2016) the learning of Physical Science cannot be confined merely to the classroom. Teachers need to encourage learners to think outside the classroom and relate concepts to everyday life. The social constructivist view involves learners engaging with each other and building on each other skills and knowledge through cooperative learning. This approach allows for achievement of fundamental thinking skills to science such as creative and critical thinking, decision making and designing, leading to improved problem solving capacities affecting society (Mchunu, 2012). It is stated that scientific theories are not deduced from data; rather they are but constructions of the human intellect (Driver, 1983). This can be typically envisioned, when teachers are teaching the concept of sound to learners. South African musical instruments such as the *vuvuzela* can be used by teachers to try and explain the abstract concepts of frequency, wavelength, pitch and loudness.

Teacher's beliefs of teaching science is also placed into a process category whereby science is taught by placing emphasis on the processes of self-discovery and problem-solving procedures (Tsai, 2002). In order to teach science using process skills and therefore the inquiry method, it is beneficial to have a proper conceptual understanding of inquiry teaching.

The Inquiry Approach

The use of scientific inquiry as a basis for instruction for the teaching of Physical Sciences draws from the idea that learners will learn Physical Sciences best when they are provided with opportunities to do Physical Sciences experiments and practical activities (Bybee, Minstrell, and van Zee, 2000); hat is, through the process of self-discovery. The fundamental nature of the inquiry approach is a very hands-on approach. It is aimed at teaching Physical Science learners skills of problem solving, making observations, collecting, comparing and analysing data, building on existing content and constructing new ideas and synthesising and evaluating conclusions (Loucks-Horsley and Mutsumoto, 1999).

Laboratory work is of vital importance in the teaching of Physical Sciences. It allows for meaningful learning to take place by affording learners the chance to engage in scientific activity within a context for thinking about and using scientific knowledge (Harris and Rooks, 2010). As the learners proceed with the activity they begin to use their ideas, while deepening their conceptual understanding of subject content as well as their understanding of how to conduct Physical Science experiments. This is what Lehrer and Schauble (2006), call science-as-practice perspective. It combines content knowledge and process skills in a manner that highlights their interconnected nature (Harris and Rooks, 2010).

This approach of inquiry based learning has become very popular in the USA and is promoted by the National Research Council (NRC) (Gaigher et al*.,* 2014). The USA emphasizing that "engaging in scientific inquiry requires coordination both of knowledge and skill simultaneously" (NRC, 2012, p. 41). By allowing learners opportunity to conduct experiments in the classroom is in fact allowing them the opportunity to coordinate their use of content knowledge and scientific skills. Lotter et al. (2007) revealed that teachers beliefs about science, the teaching process, and the learners all influence the choices teachers make during classroom practice. Teachers who perceived the concept of "inquiry" as a thinking process had adopted classroom practices that involved a questioning pedagogy, and as a result the classroom discussion was mostly teacher-lead discussions.

2.6 PROFESSIONAL DEVELOPMENT

Professional development within the context of education refers to the professional growth a teacher achieves as a result of gaining further experience and examining his/her teaching systematically (Villegas-Remers, 2003). This can be achieved through formal experiences (e.g. attending workshops and professional mentoring) and informal experiences (e.g. observations of colleagues teaching) (Villegas-Remers, 2003). "Professional development is considered an essential mechanism for deepening teachers' content knowledge and developing their teaching practices" (Desimone, Porter, Garet, Yoon, and Birman, 2002, p. 81). For the teachers to be knowledgeable there has to be a continuous sustainable comprehensive developmental programmes in place to enhance teacher knowledge (Kriek and Grayson, 2009). Dass (1999), states that to have the developmental needs of teachers addressed adequately the single "one-shot" approach is an inappropriate and will fail.

Fennema and Franke (1992), point out that research studies have suggested that the content knowledge of the teacher does in fact influence classroom practice. When new content is introduced in the syllabi, it creates a greater burden on the teacher (Bennie and Newstead, 1999) due to unfamiliarity with the content the teacher is unable to highlight certain important factors on the new content. Therefore teacher development becomes a critical point to successful implementation of educational change. When there is deficit of content knowledge then there is a need for professional development programmes to be executed (Ramnarain, 2013). However, these programmes must be tailored to the needs of the teachers. This is clearly expressed in the National Strategy for Mathematics, Science and Technology (DoE, 2001) whereby it states the need for higher education institutions to develop Rigorous, high quality and relevant training programmes for teachers that will assist in strengthening both subject matter expertise and pedagogical content knowledge.

Arnott (1994) argues that the key to successful implementation is in addition to the support that must be given to teachers during the initial stages of implementation. There must also be "continuous interaction with peers and consultants during the process of implementation" (Fullan and Pomfret, 1977, p. 44). According to Killion and Kaylor (1991, p. 64), "Training without subsequent follow-up leads participants down a dead end". Often, the initial development for teachers on new curricular material is provided at the beginning of the respective academic year. However, follow-up workshops become less regular due to obstacles such as time, disruption and expense (Arnott, 1994). Loucks-Horsley, Hewson, Mundry, and Stiles (2009) cite several principles for effective professional development in Physical Science which they mention as:

- Learning Physical Science content through inquiry: This involves teachers being able to teach science using an inquiry approach. Whereby the learners are actively involved in scientific investigations which provide them with opportunities to explore possible solutions, explain phenomena, elaborate on potential outcomes, and evaluate findings (Gillies and Nichols, 2015).

- The integration of subject matter, learning, and pedagogy: Knowledge of Physical Science content as well as content-specific strategies in identifying learners' misconceptions, promoting inquiry, and encouraging group collaboration and problem solving are critically important skills for teachers to possess in order to have effective and meaningful inquiry learning take place in their classrooms (Appleton, 2003). The confidence of the teacher in professional matters is a multi-dimensional construct. Teachers need to have the ability to draw on their declarative-conceptual pedagogical knowledge in order to recognise and fully understand a given situation (König, Blömeke, Klein, Suhl, Busse, and Kaiser, 2014). The teachers' content knowledge, pedagogical knowledge and theoretical knowledge must inter-connectedly cooperate to assist the teacher to achieve and implement effective classroom practice (Crawford, 2000); and in the case of Physical Sciences teaching through the use of inquiry.

- Build understanding as a lifelong learner: The pre-knowledge that the teacher brings into the classroom when teaching a science curriculum is of great importance. Shulman (1987) states that in order for a teacher's teaching strategy and content knowledge to be effective in the classroom, the content knowledge of the teacher has to be well developed. A teacher of Physical Sciences should constantly engage in learning in order to develop and broaden personal subject content knowledge.

- Professional development opportunities that are consistent and integrated: During classroom practice, the Physical Science teacher has to be able to capture the attention of the learners. This is achieved by providing opportunities for them to be able to "investigate natural phenomena through experimental and conceptual explorations, ask thought-provoking questions, and engage in collaborative discussions to communicate scientific ideas and develop consensus on the topic under discussion" (Gillies and Nichols, 2015, p. 173). However in order for teachers to achieve this, they would require the chance to participate in professional learning experiences. This deepens their personal content knowledge in the subject. Consequently enabling the teachers to learn the pedagogies appropriate for teaching Physical Sciences. In addition, this develops their ability to interpret and respond to observations (Duschl and Gitomer, 1991). According to Borko (2004), although professional learning activities can enhance, and/or alter teacher's knowledge, beliefs, and practices, there has to be a level of consistency and integration in the teacher's professional development activities; failing which there could be adverse effect from the professional learning workshops to the classroom practice (Gillies and Nichols, 2015).

Norman and Spencer (2005) and Montagnes (2010), reiterate the same sentiments that continuous training of teachers is fundamental for the successful implementation of any curriculum reforms. Professional development programmes are a necessity to facilitate change. However not all professional development programmes are effective. Addressing the concerns of teachers is one of the key principles to achieve an effective developmental programme for teachers (Kwok, 2014).

Bransford, Brown and Cocking, (2000), states that professional development that is ongoing and job-embedded has demonstrated improvement in science teachers' content knowledge, skills, and dispositions and it empowers teachers. Physical Science teachers in South Africa need development along three dimensions. These dimensions should be simultaneously developed. The dimensions are content knowledge, teaching approaches and professional attitudes (Kriek and Grayson 2009).

In South Africa, professional development of teachers was often referred to as in-service education or staff development (Ono and Ferreira, 2010). Currently, some researchers have argued that the “traditional professional development workshops” (in the forms of seminars, conferences or courses and workshops) that the South African government spends millions of South African Rands on are fragmented, de-contextualized, incoherent and very isolated from the real classroom practice situations. Kelleher (2003, p. 751), refers to these traditional development workshops as “adult pull-out programmes” and is of the view that it is highly unlikely for these workshops to result in improvement of teacher classroom practice activities.

According to Leu (2004), many other developing countries in the world have adopted the same top-down cascade approach. Whereby a cohort of teachers trained through short courses are then expected to train colleagues in the hope of transferring content knowledge to other teachers through the use of formal courses (Peacock, 1993). Leu (2004) posits that in this approach teachers are “passive learners” as in the case of content based education is South Africa. The problem with this approach is that there is a strong possibility that crucial information is watered down and even eliminated. On the one hand however, the advantage of this approach is that information could be quickly disseminated. Proponents of this approach argue that it is cost effective and the progress of training could also be monitored in stages (Ono and Ferreira, 2010). It is this very approach that the South African Department of Education relied on when OBE was first introduced in the country. South African researchers have argued and continue to, for alternatives to teacher professional development. According to Bransford et al. (2000, p. 27), “the principles of learning and their implications for designing the learning environment apply equally to a child and adult learning”. Just like how a teacher uses the inquiry-based approach during classroom practice and getting learners to be actively involved in the learning process; teacher development needs to have teachers actively involved. Teachers need to become active participants in their learning process. The experts / specialists in the field now become the teachers in the training; thus making learning more meaningful.

Professional Development and Classroom Practices

According to Supovitz and Turner (2000), professional development is still considered the best option for the reform of classroom practices of teachers due to the fact that many other alternate methods have also fared no better. The authors further state that policies that are introduced with the ambition to support instructional reform fail miserably due to the fact that teachers have a tendency to ignore policies that influence their basic classroom routine and practice. Therefore to have effective science professional development, researchers and teachers have come to the consensus that developmental programmes must encompass particular components (Supovitz and Turner, 2000). They argue that programmes must model inquiry forms of teaching. The advantage using programmes that model scientific reasons is that is has a greater influence on learner achievement, as compared to programmes that placed emphasis on teaching teachers to use a specific curricular (Marek and Methven, 1991).

The second, third and fourth components described by Supovitz and Turner (2000) are that professional development must be intensive and engaging. It must also involve authentic tasks that are based on the experiences that teachers have with their learners. Professional development of teachers must also focus on the subject matter content and improving the teacher’s content skills respectively. Kennedy (1998) presents that the fourth component is suggested to have a larger impact on learner performance. The fifth component of professional development of the teacher involves professional development standards that show teachers how to take the knowledge gained through a workshop and connect their work to the standards of student performance for example, dealing with problem solving skills which requires teaching strategies that set higher learning goals (Supovitz and Turner, 2000).

Supovitz and Turner (2000) revealed that when the amount (as in number of hours) of professional development (structured based on the above components) is increased, then the teachers use of inquiry based teaching practices increased and teachers established and displayed higher levels of investigative classroom culture. This therefore informs improved classroom instruction that promote meaningful learning.

Desimone et al. (2002) provides evidence that when professional development programmes are authentic and engage teachers on content focused topics with specific teaching practices, teachers tend to use the specific practices during their classroom practices. According to Rogan and Aldous (2005), research studies conducted in the Mpumalanga Province of South Africa revealed that a positive relationship existed between the levels of practical work conducted in the classroom and professional development programmes that were focused on investigative skills development. Lotter et al. (2007) indicated that after a period of extensive professional development on inquiry learning in science, although it was found that teachers did in fact increased the usage of inquiry learning in their classroom instruction, the teachers beliefs and views (discussed further in the review) did constrain their use of inquiry during classroom practice. Therefore, professional development of teachers has to be continuous, authentic, and engaging. It should also focus on developing the teacher's instructional classroom discourse thereby allowing teachers the ability to develop higher cognitive skills of the learners. Therefore, this current study posits that when professional development is meaningful with the teacher, this might have a positive influence on the teacher's classroom practice activities.

2.7 TEACHER KNOWLEDGE

Teacher knowledge is possibly the most critical aspect in a teacher's life. Teacher knowledge includes subject matter knowledge, contextual knowledge and knowledge of learners understanding (Mudau, 2016). For teachers to improve their classroom instruction and practice they must be given opportunity to expand, elaborate and enrich their knowledge systems (Borko and Putnam, 2005). According to Hill, Rowan, and Ball, (2005, p. 377), “It is not only knowledge of content but also knowledge of how to teach content that influences teachers' effectiveness”. The teaching of any subject is a highly complex cognitive activity during which the teacher must apply knowledge gained from multiple domains (Magnusson, Krajcik, and Borko, 1999). The consensus in teacher education is that, strong knowledge of the subject being taught is a core component of the teacher's competence (Baumert, Blum, Brunner, Lordan, Klussman, Krauss, Kunter, Neubrand, Tsai and Voss, 2010). Research studies have found that teachers who engaged in a greater number of courses in the subject they taught, had a better content knowledge of the subject and as a result the performance of their learners during classroom practice was much higher. The repertoire of teaching strategies and explanations available to a Physical Science teacher in the classroom is largely dependent on the breadth and depth of personal conceptual understanding of the subject (Baumert et al., 2010).

Teacher content knowledge is critical for effective classroom practice. Insufficient content knowledge limits teacher capacity to explain and represent that content to learners in a sense-making way. This is a deficit that cannot be merely offset by better pedagogical skills (Baumert et al., 2010). According to Magnusson et al. (1999), teachers with differentiated and integrated knowledge possess a greater ability to develop classroom instruction that help learners develop a deeper and more integrated understanding, as opposed to teachers whose knowledge is limited and fragmented. Therefore Grossman (2008) states that in order for instruction to be of high quality, the content knowledge that the teacher possesses is not merely general knowledge that is picked up incidentally but came through professional and specific knowledge that is acquired through university-level training. This knowledge could be cultivated through systematic reflection on classroom experience of the teacher.

When teachers make use of multiple pedagogical strategies to transform their existing knowledge of the subject content into a form that could be easily understood by learners, this is termed ‘pedagogical content knowledge’ (Shulman, 1986). Cochran, King and DeRuiter (1991) illustrate that the teaching process as transformational, during which the teacher critically reflects on and interprets the subject matter makes use of analogies, metaphors, examples, problems, demonstrations, and a variety of classroom activities to represent information to learners; as well as adapts the learning material to the cognitive level of learners. When a teacher delivers his/her content knowledge to a class it is done based on the teacher’s knowledge of his/her learners (this includes the learners ability, age, cognitive developmental levels, attitudes and their prior knowledge of the topics being taught), and the teachers understanding of the context (which includes physical environment in which the learners are required to learn, learner discipline, socio-economic status of learners, extensive syllabus etc.) (Cochran et al., 1991; Mudau, 2016).

It is essential that a teacher in any classroom has an understanding of his/her learners differing needs towards learning. Teaching any subject is a highly complex cognitive activity in which the teacher must apply knowledge from various domains (Leinhardt and Greeno, 1986). For example if a teacher is teaching the concept of endothermic and exothermic reactions and conducts an experiment to determine whether a reaction is endothermic or exothermic based on the change in temperature for example, the teacher must first ensure that all his/her learners know how to use a thermometer. The teacher must have what Magnusson et al. (1999) terms prerequisite knowledge of what is required for learners to learn specific concepts and this includes knowledge of the abilities and skills that the learners may require. Depending on the cognitive levels of the learners the teacher may structure teaching using types of classroom instruction (for example instruction that makes use of the traditional approach to teaching or instruction that facilitates radical and social constructivism).

According to Magnusson et al. (1999), teachers must have pre-knowledge of what their learners already know about Physical Sciences as well as any misconceptions they may have. Teachers must also have an idea of the topics that learners perceive as difficult. Several studies have documented learners’ misconceptions are present at various levels of schooling and in a variety of scientific domains and science concepts (Magnusson et al., 1999). Collins and Stevens (1980) were of the view that when concepts are abstract and do not relate to the everyday life of the learner, then due to lack of experience, it is perceived as difficult. Problem solving presents difficulty when learners fail to apply their mind critically as well as strategically to a situation.

In South Africa, the “classroom contexts are complex and diverse in terms of resources, curriculum, constraints placed on the teacher, educational and cultural backgrounds of students and teachers, class sizes, and all these are factors in the degree to which educational change manifests” (Ramnarain and Schuster, 2014, p. 629). A motivated teacher would display a positive attitude in his/her field of specialisation. The teacher's classroom will reflect the subject being taught and will encourage teaching and learning.

However there is a possibility that a teacher who may be highly motivated about teaching Physical Sciences is presented with challenges in the classroom. For example, learners whose home language differs from the medium of instruction might present different challenges to the teacher. According to Rammala (2009), many learners in South Africa whose home language might not be the language of instruction in class struggle in English communication. This puts these learners at a disadvantage during examinations since that is the language used to respond to questions. Dhurumraj (2013) and Sayed et al*.* (2007) cited this complexity as being prevalent amongst rural-based South African learners. These are areas where the LoTL (Language of Teaching and Learning) differs from the home language of learners. This complexity makes learning abstract concepts in Physical Sciences very difficult.

Teacher Knowledge and Classroom Practices

According to Ramnarain (2013, p. 2), "studies on the relationship between teachers' content knowledge and their classroom practices show clearly how teacher content knowledge influences their PCK". These studies have further revealed that those teachers who lack specialist content knowledge were highly likely not to implement inquiry-based teaching strategies during classroom practice. These teachers were in fact highly dependent on the traditional methods of classroom practice (Ramnarain, 2013). Hashweh (1987) found that teachers reflecting better subject content knowledge would also display such knowledge showing quality in analogies. However, these teachers would also tend to use more explanatory knowledge representations. They also reflected richer non-topic disciplinary knowledge.

Carpenter, Fennema, Petersen, and Carey (1988) revealed that novice teachers often resorted to basic level one type questions. These questions are described as referring to basic recalling of knowledge (as described in Table 1d, Annexure A). They tend to rely on subject matter extracted directly from the text book, and they tend to make very broad pedagogical decisions without performing any diagnostic[2] based assessments. Teachers who lacked specialist content knowledge were unenthusiastic implementing inquiry-based teaching strategies during their classroom practices (Adams and Krockover, 1997; Lee and Luft (2008). Such teachers resorted to a more closed and constrained pedagogy with a high level of dependence on the textbook. Classroom practice under these

[2] A type of assessment taken at the beginning of a study unit, in order to determine skills, abilities, experiences, views and levels of achievements or difficulties in a class or individual learners.

circumstances becomes unilateral and limiting to learner exploration abilities and exploitation of classroom opportunity and activity. Grossman (1989) points out that although some teachers may have a great deal of content knowledge in the subject, many of those teachers still struggle to transform this information into understandable form to learners. Hill, Rowan and Ball (2005) state that PCK is inconceivable without sufficient content knowledge. Content knowledge is required together with pedagogical content knowledge to stimulate meaningful learning.

In the South African Education system it is widely acknowledge that the teachers' orientation towards the teaching of Physical Science requires that the teacher understands the possible approach that he/she will use to teach a particular topic. The approach could be based on processes or content only or it could encompass a bit of both; leading to inquiry-based classroom practice (Magnusson et al., 1999). The approach influences the classroom instructional decisions of the teacher. For the teacher to develop personal approach, such teacher must possess knowledge of the Physical Science curriculum. This knowledge does not only refer to the curriculum content but also the requirements of the curriculum. The teacher therefore needs to be familiar with the CAPS document, time allocation for the topics to be covered, and the skills that the subject wishes to imbue in learners.

The teacher needs to have sufficient pre-knowledge of Physical Sciences as this helps the teacher determine the types of assessment he/she will use in teaching a particular topic. This will be based on what skills the learner is required to develop on the topic. Lastly, the teacher is required to possess sufficient knowledge on subject-specific[3] strategies as well as topic-specific[4] strategies. Many teachers shunned changes to their classroom practices because of desire to their classroom practice beliefs.

2.8. CHAPTER CONCLUSION

This chapter reviewed empirical studies on science teacher's classroom practices. Literature on the performance, teacher's beliefs, teacher knowledge and professional development for teachers have been reviewed in this chapter. The reviewed literature provides a basis for the analysis of data collected and discussed. In the next chapter, the conceptual framework for this study is presented.

[3] Teaching strategies specific to teaching Physical Science.
[4] Teaching strategies for a particular topic in Physical Science.

CHAPTER 3

CONCEPTUAL FRAMEWORK

3.1 DEVELOPING THE CONCEPTUAL FRAMEWORK

A conceptual framework is the under-lying philosophy on which research takes place. Conceptual framework bears implications for every decision made in the research process (Sinclair, 2007). The framework used is concerned with understanding human practices (teacher's classroom practices) within a social context (the school), from the teacher's point of view. The ontology of the study is that teacher realities are socially constructed. Teacher realities could therefore be understood from the teacher's perspective. The epistemology is interactive because the understanding of parts (teacher knowledge, teacher beliefs and professional development) leads to an interpretation of the whole (teacher's classroom practices) and the whole an interpretation of the parts.

Teacher Knowledge

Teacher knowledge is not confined to subject knowledge only, it includes knowledge of the learners and of the teaching environment. The Classroom Practice Diagnostic Framework (CPDF) employed by Mudau (2016), was used in diagnosing the classroom practices of the grade 12 teacher, in teaching "vertical projectile". Mudau's (2016) model revealed that the teacher knowledge, instructional strategies, and interactions and discourse were used to diagnose the classroom practice of the teacher. As Mudau (2016) explained, each aspect of the model was informed by the other. Teacher knowledge is considered the main source that influences the teacher's actions during classroom practice (Mudau, 2016). Teacher knowledge informs the type of instructional strategies developed during classroom practice. This leads to classroom interactions and discourse. Teacher knowledge was therefore of major interest to this researcher. Mudau (2016) lists what might be called categories of teacher knowledge. The following section mentions and discusses in brief each category.

- *Content knowledge:* this includes teacher understanding of the subject content.

- *Learner understanding:* this implies teachers understanding of the learners' strengths and weaknesses in the subject. It is stated that scientific theories are not deduced from data as they are constructions of the human intellect (Driver, 1983). Teachers therefore need to have an understanding of the learner's prior knowledge (Mudau, 2016).

- *Context Knowledge:* this refers to contextual aspects such as resource availability, socio-economic background and the curriculum. These influence the teaching of the subject.

Professional Development

Learning is never constant. Teachers are also required to constantly update their knowledge in their field of specialisation. Teacher's professional development is profoundly essential. In the educational context, professional development of teachers is achieved when teachers continuously improve and gain knowledge which will assist them in their classroom practices (Desimone, Porter, Garet, Yoon, and Birman, 2002). Professional development might take place formally through teacher workshops and/or informally when the teacher engages and observes colleagues in classroom practice (Villegas-Remers, 2003). To attain effective professional development in classroom practice, Supovitz and Turner (2000) proposed that:

- Teacher professional development must occur at the school level. In this regard, the School Management Team (SMT) should provide teacher support.

- More sophisticated teaching strategies should be developed in teachers. This would enable the teachers to develop higher learner cognitive ability.

- Professional development of the teacher should seek to broaden teacher content knowledge.

- Development tasks should be authentic and relevant to teacher experiences.

- Teacher development should be ongoing and intensive programmes.

- Teacher development should be designed on a Model Inquiry form of teaching which might include experiments and questioning.

For this study, teacher profession development is defined as the continuous process of equipping both experienced and novice teachers with the necessary and applicable knowledge and skills required to effectively and efficiently deliver a successful grade 10 Physical Sciences curriculum in a South African classroom.

Teacher Beliefs of Teaching and Learning

Teacher's beliefs and practices cannot be examined out of context because the relationship between teachers' beliefs and their practices is always complex and in addition context dependent (Mansour, 2008). Consequently, the beliefs of science teachers would play a major role in shaping science education (Lumpe et al., 2000; Tsai, 2002). It is also worth noting that teachers' beliefs on teaching and learning are often identified as an obstacle to the successful implementation of curriculum reform (Morgan and Xu, 2011). This study defines therefore teacher beliefs as the attitudes, thoughts, judgements and prior decisions which influence teachers classroom practices (Shavelson and Stern, 1981; Clark and Lampert, 1986).

Teacher beliefs in the teaching and learning of Physical Sciences are divided into two broad categories. The categories involve traditional beliefs and the process/constructivist beliefs.

The traditional belief of teaching and learning science involved:

- Teaching of science as a collection of facts in the classroom. The use of scientific process skills is very limited (Lotter et al., 2007).
- The transfer of knowledge, i.e. from teacher to learner with scientific facts (Tsai, 2002).
- The use of theories to explain findings in science (Brickhouse, 1990).

The Process and constructivist beliefs of teaching and learning science incorporated:

- Emphasis being placed on the processes and problem-solving procedures of science (Tsai, 2002).
- Teaching science by making use of learner's prior knowledge and building on the existing knowledge (Lotter et. al., 2007).
- Classroom practices that involve effective classroom discussion, cooperative learning and provision of authentic tasks to learners (Tsai, 2002).

3.2 EXPLAINING THE INTERRELATIONSHIP BETWEEN TEACHER KNOWLEDGE, PROFESSIONAL DEVELOPMENT AND TEACHER BELIEFS

The inter-relationships amongst teacher knowledge, professional development and teacher beliefs can be represented as in figure 3 below.

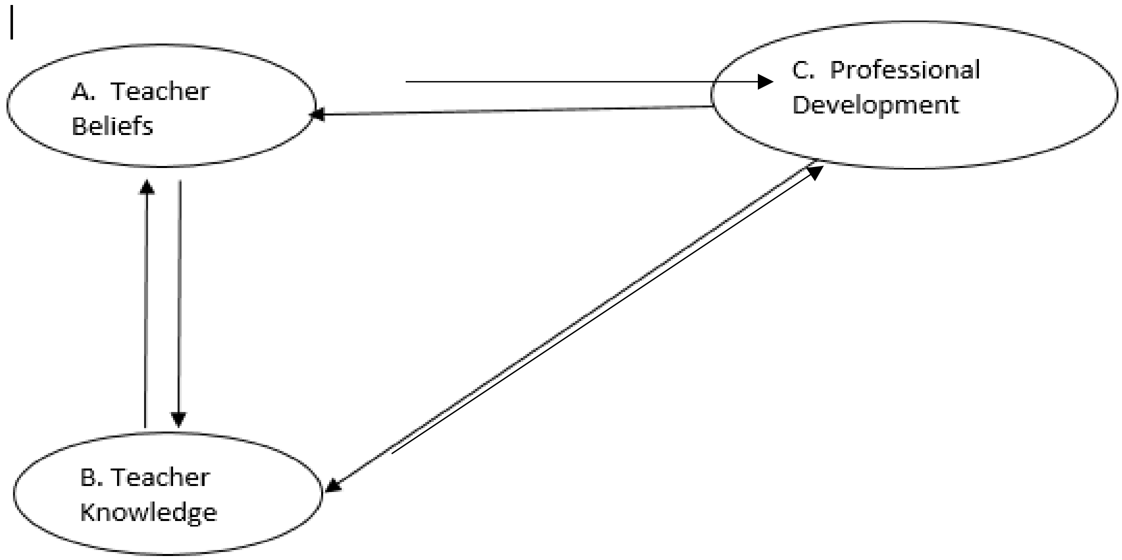


Figure 3: A Schematic Representation of the Conceptual Framework.

Figure 3 consists of three frames. Professional development (frame C) is the most important frame. It is considered a crucial factor that expands on the teacher's knowledge (frame B) and thus therefore shapes the teacher's teaching practices (Desimone et al. 2002). Professional development is also influential on the teacher's beliefs (frame A). However teacher knowledge (frame B) also influences teacher beliefs (frame A) and *vice versa*. Mansour (2008) states that when the teacher's knowledge expands and becomes more articulate, a highly personalized pedagogy or belief system is developed consequently controlling the teacher's perception, judgement, and behaviour. When the teacher engages in meaningful, on-going professional development (frame C) teacher beliefs in the teaching of Physical Sciences might change. Teacher beliefs in the teaching of Physical Sciences are often shaped by their own experiences as learners. Teachers use these experiences in their daily classroom practices. As a result necessary scientific skills may not be developed in the learners if the teaching methods employed by the teacher are only predominated by lecturing and demonstrations.

Teacher knowledge also influences the teacher's beliefs on the teaching and learning of Physical Sciences. For example, the teacher is expected to have sufficient knowledge of the learners' common misconceptions, their prior knowledge and linguistic abilities (i.e. teacher understanding of learners). Thus to allow for a conducive and appropriate learning environment promoting better understanding amongst the learners (Eryilmaz, 2002; Galus, 2002; Hausfather, 2001). The subject matter knowledge of the teacher refers to the teacher's organization of the content and how well the teacher understands the content (Kind, 2009; Hausfather, 2001). Context knowledge of the teacher refers to all the contextual features that could influence the teaching of the subject matter such as the availability of resources, socio-economic background of learners and the curriculum for example. These are expected to impact on the teacher's classroom practices. Professional development of the teacher should create opportunities for teachers to share their best practices, teaching pedagogy and improve teacher content knowledge. By understanding the nature of teachers' beliefs and teacher knowledge, professional development programmes that cater for their needs can be developed. Consequently allowing for meaningful teaching and learning in the classroom. This is because the teacher is expected to teach Physical Science in a grade 10 classroom in a manner that facilitates the development of basic understating of concepts.

3.3. THE APPLICATION OF THE FRAMEWORK

The above conceptual framework was used in diagnosing how the experiences of a teacher would shape classroom practices.

By examining teacher knowledge, the above conceptual framework was able to determine,

- How good the teacher's content knowledge was.
- The teacher's understanding of learner's misconceptions, their prior knowledge and their cognitive abilities.
- How contextual factors such a length of the syllabus, resource availability and socio-economic status of learners influence classroom practices.

The framework was used to determine how professional development of a grade 10 Physical Science teachers influences classroom practice. The framework further diagnosed how the beliefs of teachers towards teaching and learning of Physical Sciences had influenced their classroom practices. For teachers that believed "school science" was separate from "real science" had a tendency to focus on curriculum delivery only (Laplante, 1997) consequently following the traditional approach in the teaching of Physical Sciences. Some teachers still held onto some vivid images of teaching the sciences from the experiences they had gathered while still learners. These images strongly influenced the translated knowledge and projected practices these would apply as teachers (Calderhead and Robson, 1991).

3.4. CHAPTER CONCLUSION

This chapter introduced and explained the conceptual framework of the study. In the next chapter the research methodology is discussed.

CHAPTER 4

RESEARCH METHODOLOGY

4.1. INTRODUCTION

This chapter presents the research methodology adopted for this study. This chapter is necessitated by the fact that research is a systematic process of collecting, analysing, interpreting and recording results of the particular study based on the data to achieve a certain purpose (McMillan and Schumacher, 2006). Methodology assists the researcher to access and record the highest quality of data needed for the study.

For several continuous years the performance of learners in Physical Sciences in the National Senior Certificate examination in South African schools has showed a steady decline. This decline continued two years in succession (2014 and 2015) with the introduction of CAPS. Grade 10 creates the foundation to learning specialist subjects. This qualitative study is therefore aimed at understanding teacher experiences and how the same shapes classroom practices of the teacher. Teacher classroom practice influences learner performance. This study was undertaken in Kwa-Zulu Natal Province. However, because of the vastness of the province, this study focused on one selected district. Three teachers from the district were selected using a set of criteria explained elsewhere in this chapter. This study examines in addition, teachers' beliefs in Physical Science and how such beliefs influence teachers' classroom practice philosophy. In other words, this study links teachers' beliefs with quality of subject content knowledge the teacher possess and how the teacher engages in the teaching of the subject. Amongst others, the teacher's choice of classroom practice strategies and the subject content knowledge form the bedrock of this study. Ethical considerations are accounted for in this study.

4.2. QUALITATIVE CASE STUDY APPROACH

This study is descriptive and explanatory. The study therefore adopts a qualitative research design. This design was preferred because of its ability to allow for flexibility in the discourse of the research. Also, the design emphasises the lived experiences of individuals taking their context into account (Neumann, 2000). The choice and preference of this design is further strengthened by the insinuations made by Babbie (2004). Babbie (2004) contended for this design in this nature of studies arguing that an intense study of a particular case can generate explanatory insights. A case study design is adopted because it is interactive and allows for the researcher to observe characteristics of an individual (in this case the teacher) within their context (Baxter and Jack, 2008; Cohen, Manion, & Morrison, 2013). The data analysis focused on one phenomenon, which is the experiences of teachers and consequently how these experiences shaped teachers' classroom practices.

Data sources for this study was based on what teachers said during interviews and what was noted during classroom observations. To triangulate that which teachers said and what was observed, some of the answers were sought from questionnaires. The case study helped to ensure that teacher experiences are not explored through one lens but rather from an assortment of lenses (interviews, observations and questionnaires) through which data is interpreted. This simplified understanding of the teacher's experiences.

4.3. NATURE OF THE RESEARCH

Cohen et al., (2013) explain that an interpretive research paradigm is one that accepts that reality is a construct of the human mind. This study is underpinned by the hermeneutic/interactive paradigm. Its focus is on understanding the lived experiences of teachers and their points of view based on their social context. This study made use of several means to understand the nature of teachers' experiences because reality is socially constructed and therefore there are many ways of perceiving that which is seen.

This study takes place in the natural environment of the teacher, i.e. the classroom. The individuals are not detached from their setting. Data analysis and inferences are based on interviews and observations (which were recorded) made by the researcher during this study. Assumptions made are that the teacher's long experience in the teaching of the subject consequently familiarises the teacher with the properties of the CAPS. The researcher's understanding of the value of a proper background or foundation in the latter phases of the subject with regard learner performance comes in handy for this study. Furthermore, the researcher has also gained valuable experience on teacher professional development because of the many workshops the researcher has attended as a Physical Science grade 10 teacher at some point. This augmented by the researcher's experience as an examiner for Physical Sciences for the Department of Education. This experience aids the resultant interpretations and conclusions the researcher makes for this study.

4.4. AREA OF STUDY

This section describes the research setting. The criteria used to select the schools is also briefly but comprehensively explained. This is then followed by a brief description of each participant school.

4.4.1 The Setting

This study was undertaken in the Republic of South Africa (RSA). The Republic of South Africa consists of nine administrative and political regions known as provinces. Because of the geographical vastness of the Republic of South Africa, it was always going to be impossible to undertake a study of this nature nationally. This study was therefore scaled down to only one province and subsequently one district. The province is Kwa-Zulu Natal. The selected district had approximately one hundred and thirty two schools (n=132) under its administration. The schools were grouped into smaller clusters of neighbouring schools this was done by the Physical Sciences subject advisor. The clusters were meant to improve the quality of the standards on learner formal assessment tasks. The clusters also assisted in promoting teacher cooperation and collaborations in respective subjects - especially where teachers were expected to share subject information. It was assumed that teachers would substantially gain assistance from each other - especially where teachers would have limitations. The clusters had to ensure standardization across all schools. Some schools therefore would write similar examinations and tests. These are called cluster examinations.

Formal education has three categories; grade R to grade 3 (foundation phase), grade 4 to 6 (intermediate phase), grade 7 to grade 12 (senior phase) and the higher education phase of vocational colleges (FETs) and universities. Education in the pre-primary, primary and secondary phases is governed by the Department of Basic Education (DBE). Each of the nine provinces has its own Provincial Department of Education (PDE) which is divided into administrative geographical districts. These districts comprise of clusters. Clusters are made of a number of neighbouring schools. At the districts there are subject specialists or subject experts and part of their role is to assist the teachers with difficulties they may experience in the day-to-day practice in respective subjects. These subject experts also have to report to the PDE on the performance of schools in the respective district where they are based. This arrangement is made to ensure quality teaching and learning. In addition, this assists in the monitoring of teachers' work with regard teachers following work schedules; conducting assessments on learners and if such assessments are following the required weighting and cognitive levels as stipulated by the CAPS document for the respective subject. Finally, the subject advisors monitor the teachers to ensure that there is proper recording of learner portfolio with regards test marks, and so forth. In Physical Sciences, the patterns are also as in these other subjects.

4.4.2. The Sampling Process

The criteria used for the selection of samples are described below. This section also gives a brief on the process used in the selection of participant schools in the respective district. This study follows the definition of Seaberg (1998) on what a sample is. Seaberg (1998) defines a sample as a small proportion of the total set of objects, individuals or events which together make up the subject of a study.

The Criteria and School Selection Process

Only schools within 15 km radius from the district office of education were considered for selection. The rationale behind this criterion is that the teachers in these schools would be part of a cluster[5]. Clusters met on a frequent basis. The selection had to consider the movement of participant teachers from their bases to the meeting point[6](s). If the distances were to be too large, the teachers would have found participation difficult. Therefore, 15 Km was at least fair. The meeting point at 15 Km radius was also proximal to the researcher to travel to the schools. Only permanently employed teachers in the respective participant schools were selected. This was to avoid possible disruptions emanating from teachers moving out of the respective schools before the completion of the study should such teachers otherwise moved base.

Selected teachers had to be in possession of a recognized formal teaching qualification. Teacher qualifications and training would influence classroom practices (Rogan and Grayson, 2003). Protocol was followed by all and teaching and learning was not disrupted by outbursts of chaos and violence in the selected schools. All schools selected would have been exposed to the same workshops and teaching material.

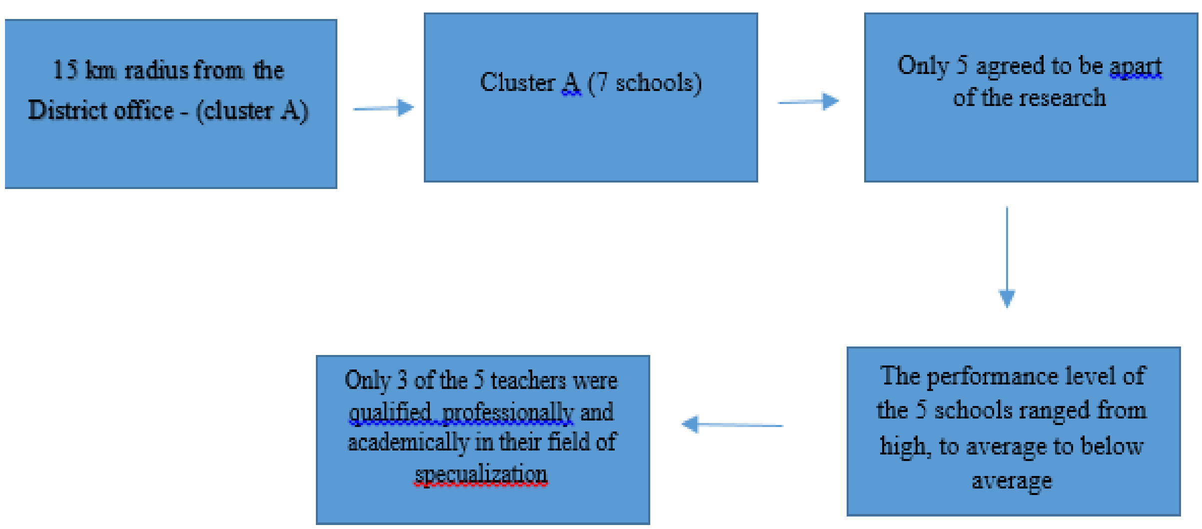


Figure 4: The Process of Selecting Schools

[5]Cluster refers to a number of neighboring schools that are close proximity to each other which make up a group.

[6] Meeting Point refers to the location where teachers from a cluster would meet for the sharing of resources in Physical Sciences.

The selection process is represented in figure 4.

The researcher made a list of schools in the district which were within the 15 km radius preferred for this study. Subject advisors[7] in fact advised that as far as possible teachers should be selected from the same cluster. These clusters often met throughout the year, and they also shared resources. Those teachers who did not belong to the respective cluster were therefore excluded from the study. The selected cluster comprised of eleven schools. The questionnaire (Appendix 2) was administered to all members of cluster after a workshop presentation. Results indicated that only seven schools fell within the 15 Km radius. Five school principals out of the seven approached agreed that their school would be willing to participate in the study. On condition that the identity of the school and the participant teachers (n=5) were not divulged to third parties at any point of the study discourse. Although all five teachers were teaching grade ten Physical Sciences, only three out of the five teachers had a recognized professional teaching qualification and an academic qualification, e.g. a Bachelor of Science Degree in their field or any equivalent qualification in their field of specialization. The remaining two teachers who were willing to participate in the study did not meet the criteria (they did not have a recognized formal teaching qualification) for the study to be allowed participation. However, these teachers were absorbed as part of the pilot testing of this study. Thus a total of five teachers volunteered to be a part of the pilot study.

Each of the selected schools had Physical Science teachers that had their own unique experiences with the implementation of the Curriculum and Assessment Policy Statement for Physical Science. Some teachers were new in teaching i.e. they had just entered the profession, while others have been teaching for well over two decades.

4.4.3 The Selected Schools

This section describes each of the participant schools selected for this study. To keep to the ethical commitments of this study, pseudo names of the schools and the participant teachers are used instead:

I) Ms Avos from Avos High School

The Setting

Avos high school is a state school established in the early 1950's. Based in the urban area, Avos has been predominantly attended by mostly Indian and African learners during the apartheid regime. This is a multi-cultural and multi-faith based

[7] Individuals that are considered experts in the subject content knowledge and vested with the task of moderating and guiding teachers with the teaching of Physical Science

school. The medium of instruction for the school is English. The school is equipped with an operational Physical Science laboratory although some critical equipment is in a state of disrepair; the fume cupboard being one such equipment. There are many charts and posters relating to the subjects. The seating plan is fixed in that there are seven rows of desks that are fixed to the ground and two benches at each row that seats an average of four learners per bench in the laboratory. Some of the desks have gas taps attached as well as basins with a water tap. The basins are filled with sheets of unwanted paper while all the gas taps have been broken off. There is evidence of vandalism to the desks such as obscene graffiti. The teacher’s workstation is situated at the front of the laboratory with the teacher's laboratory table fixed to the ground. Its tap and basin are however still functional.

There is also evidence of some improvement in the laboratory with a portion of the equipment storage wooden cupboards removed and replaced with granite top cupboards. All fixed furniture have never been replaced since the school has opened its doors to learners over some 50 years ago. The Physical Science laboratory has an extensive amount of chemicals and apparatus available that is stored in what is called an “anti-room”. In this room there are shelves which have been alphabetically labelled. The liquid chemicals are stored on the floor for safety reasons. In this “anti-room” learner portfolios are also stored here. There is also a teachers' cupboard. The teachers' files and text books are also stored here. The Physical Science laboratory is fitted with two chalkboards. There is a projector screen although the projector itself was nowhere to be seen.

This school followed a five day timetable cycle. Each lesson period lasts 57 minutes. The school day starts at 8:40 am and ends at 2:30 pm. The teacher meets the Physical Science class daily for 57 minutes in the laboratory. Teachers are form-based, i.e. teachers remained in their base rooms and learners came to them. There is only one class of Physical Science per grade. The grade 10 Physical Science class has a total of 43 learners.

The Staff

School Avos has a teacher staff population of 37. These teachers are of different cultural and racial backgrounds. Effectively, School Avos is a multi-racial school. There are at least six science teachers at this school who are managed under the Department of Science. It is only Ms Avos who teaches Physical Science in all grades of all the science teachers at the school. The principal of the school occasionally would also assist in the teaching of the subject, but only in grade 12. The principal would however only focus on the subject sections where Ms Avos still showed some difficulty teaching. This includes sections in electro-dynamics and the work energy theorem for example. When the principal would be teaching to assist Ms Avos, she would be observing the proceedings. Ms Avos has been teaching at the school for the past eight years. She teaches natural and Physical Sciences. At the time of this study, the remaining five teachers had not taught Physical Science for almost over a decade. In fact, their field of specialization was life science. It is the same set of the six teachers that teach Natural Sciences to both grade eight and nine learners in the school.

The Learners

This school consists of both male and female learners. Majority of the learners are of the African race group. The majority of these learners are second language because their home languages are something-else other than the language of instruction; English. The Physical Science teacher indicated that many of the learners came from poorly-resourced households with low household incomes. These learners often have to make decisions on how to spend their limited resources - whether on a meal or bus fare to school. The reason here is that the majority of the learners are commuting between home and school on daily basis. In addition, there were learners who were from child-headed households. The grade 10 class comprises of forty three learners (n=43) who all take Physical Science as a subject. A mere three (n=3) out of the forty three (n=43) learners' home language was the same as the Language of Teaching and Learning of the school. For the remaining forty learners (n=40), English was a second language. In the grade 10 class, each learner is provided with a school text book, and instructed to carry it to class on a daily basis. Learners are required to purchase a three quire hard cover note book for Physical Science catering for Chemistry and Physics.

II) Mrs Sassy from Sassy High School

The Setting

Sassy High has a total of 890 learners. The medium of instruction of this school is English. The Language of Teaching and Learning is the same as the home language for approximately eighty percent of the learners. The school has a Physical Science laboratory with limited resources to conduct experiments, as not all the equipment is in working order. Each grade has four lessons of 50 minutes each per week. All learners remain in their form/base room, i.e. they are form-based with the exceptions of the specialist rooms like laboratories. The grade 10 class has their Physical Science lessons in the Physical Science laboratory. The school has a weekly Tuesday subject assessment programme. Mrs Sassy is the Head of Department for Physical Sciences.

The Staff

Sassy High school has a teaching staff of approximately thirty eight (n=38). The staff consists of both male and female educators. However the school has a larger female teacher population. Teacher experience ranges between a few months to approximately three decades. There are two Physical Science teachers at Sassy High.

The Learners

Learners comprise of both male and female. The learner population comprised of Indian, White, Coloureds and Africans.

III) Mr Hill from Hilled High School

The Setting

School Hilled is a state school. This school has been in existence for well over three decades to date. The school hosts grade eight to 12. The medium of instruction is English. There are six Physical Science lessons per week of 50 minutes each. The school day starts at 8:40 am and ends at 2:30 pm. Mr Hill would meet his Physical Science class daily in the laboratory. There is also only one class of Physical Science per grade. There are thirty two learners in the grade 10 Physical Science class (n=32). The seating arrangement includes desks that are movable and a teachers' table that is fixed at the front of the class. A few chemicals are stored in a wooden cupboard at the front of the classroom.

The Staff

The school has 31 teachers (n=31) who are highly dedicated to teaching and learning. There are two Physical Science teachers (n=2) at this particular school.

The Learners

The learner population consists of both male and female learners. These learners are from the local township areas. Majority of the learners are African and English is second language to them. The socio-economic status of many of the learners is very low. There are thirty two learners in the grade 10 Physical Science class (n=32). All learners are in possession of a Physical Science text book and a two by two quire note books, i.e. one for Physics and one for Chemistry.

4.4.4 Teacher Dynamics

4.4.4.1 Teacher Academic Qualifications

Three teachers from one of the Kwa-Zulu Natal department of education districts participated in this study. All teachers were permanent members of staff at schools in the urban area. Each teacher was in possession of an academic qualification that warranted him/her to teach Physical Sciences. The teachers in the sample also had to be qualified on paper to teach Physical Science at least in grade 12. That is, they needed to have studied Physical Science either at diploma, degree or advanced certificate qualification. This was central to the study; according to Rogan and Grayson (2003) because the level of training and qualifications of the teacher might have influence on how the teacher handled classroom practices.

CASE 1: Ms Avos

Ms Avos has a Bachelor of Science Degree and a Post Graduate Certificate in Education. Her areas of specialisation are Natural Sciences and Physical Sciences. Ms Avos also teaches grade 12 Physical Science.

CASE 2: Ms Sassy

Mrs Sassy is a grade 12 teacher who has been teaching at the current school for over a decade. Her qualifications include a junior secondary education diploma, a Bachelor of Education degree with majors relating to Natural Sciences and Physical Sciences.

CASE 3: Mr Hill

Mr Hill has been teaching Physical Sciences since 1972. Mr Hill holds a degree in science. During his years of teaching he also taught Biology which is now known as Life Sciences. Mr Hill also currently teaches Natural Sciences in addition to Physical Sciences up to grade 12. Mr Hill has experience in teaching both at state and independent schools both locally and abroad.

4.4.4.2. Age Group and Years of Experience Teaching Grade Ten Physical Sciences

Based on the information in table 2, the participant teachers in this study varied in the age distribution category. Mr Hill and Ms Sassy were considered to be senior teachers for this study as they had more than a decade of teaching experience. All three teachers have however been teaching grade 10 Physical Sciences under the CAPS for a period not more than three years.

Table 2. Age Group of Selected Teachers and their Years of Experience teaching Grade Ten Physical Sciences

Respondent Teacher	Ms Sassy	Ms Avos	Mr Hill
Age Category	45-50 years old	21-31 years old	60 years old
Years of Experience Teaching	More than 10	More than 3	More than 10
Years of Experience Teaching Grade 10 Physical Sciences under CAPS	More than 3	More than 3	More than 3

4.5. RIGOUR

To ensure rigour in this study, the following measures were undertaken:

- Piloting Instruments,
- Validity,
- Methodological triangulation, and
- Verisimilitude was used as a method of reporting.

a) Piloting Instruments

Before the actual research for data collection began, a pilot study was conducted. It is important that the instruments used in the data collection be piloted. The instruments were piloted with several teachers of Science. This was to ensure validity and reliability of data, and to furthermore remove any possibilities of ambiguity and error in the instrument so that the results obtained could be trustworthy. These instruments were also sent to the researcher's supervisor for comments. Observations from the pilot study were that:

- Many teachers were sceptical with classroom visits during classroom practice. As a result, good rapport had to be established between the researcher and the participant teachers. This was achieved through multiple informal conversations.
- Some questions were ambiguous and were then corrected.
- Grammatical errors were corrected.
- The pilot study further allowed for the literature review to be shaped accordingly.

The pilot study created a good foundation for the main study to be launched.

b) Internal Validity

To ensure internal validity, all findings that were derived for this study were based on data collected for this study only (Maxwell, 2008). To ensure the trustworthiness of the study all data collection instruments were therefore piloted. Participants were informed of the procedures involved in the study. Anonymity was also guaranteed. A degree of rapport, trust and respect between the researcher and the teachers was established.

c) Methodological Triangulation

In this study methodological triangulation was used. This refers to the cross validation of the multiple data sources. The results of questionnaires, observations and interviews and recordings were used to corroborate the data (that was collected from the participants) (McMillan and Schumacher 2006) from which inferences were later drawn.

d) Verisimilitude was used as a method of reporting

Direct quotes and information from the participants were used during the data presentation and discussion. This enhanced trustworthiness.

4.6. DATA MANAGEMENT

The data collection techniques, its processes, methods of analysis and interpretations are discussed under this section.

4.6.1. Data Collection Techniques

This study made use of multi-method strategies for data collection. The advantage of using a multi-method data collection strategy is that it permits triangulation of data (McMillan and Schumacher, 2006). Data were collected through observations of the teacher, questionnaires and interviews with the teacher.

4.6.1.1 Interviews

Interviewing is regarded as a universal mode of systematic enquiry (Holstein and Gubrium, 1995). The advantage of interviews was that the researcher could adapt the questions (if necessary) during the interview process (McMillan and Schumacher, 2006). Non-verbal communication signs were also observed and taken into account during data collection. Interviews probing and getting clearer responses to questions - especially where responses to the questionnaires were thought to have been unclear.

Semi-structured interviews were used in this study. It allowed for teachers to describe their experiences and attitudes towards teaching of grade 10 Physical

Sciences in greater detail. Interviews were conducted over the data collection period. The researcher intended to interview teachers immediately after the lesson observation, however this was not always achievable due to the teacher having to rush for the next lesson in class. Teachers were interviewed during free periods. The interviews focused in the main on teacher content knowledge, teacher beliefs on classroom practices in Physical Science and their professional development. A minimum of three interviews was done per teacher. The minimum duration was 15 minutes as teachers were very reluctant to give off their free time. Data was captured as written responses, recorded or both. However not all teachers in this study agreed to being recorded.

4.6.1.2 Observations

Data were also collected in the form of field observations. A minimum of three, and a maximum of five observations were carried out per participant teacher (appendix 25). The reason for limiting the observations to five was because many teachers did not feel comfortable being observed during classroom practice. The researcher did not want to interfere with teaching time. An observation guide was developed (Appendix 5 and 6) and used during these observations.

4.6.1.3 Questionnaires

A questionnaire is a common method used for data (McMillan and Schumacher, 2006) collection. The questionnaires were given to corroborate that which was done in class and what the teachers claimed they did. It also allowed for the participants to freely express themselves without any fear of any victimisation or judged. The questionnaire instruments were anonymous. Teachers also had to respond at their own convenience. The questionnaires were given to teachers during phase two of data collection.

4.6.1.4 Artefact Collection

Artefacts such as teacher work schedules for the academic year (Appendix 10), and teacher workshop schedule (Appendix 14) were also collected.

4.6.2 Data Collection Process

.This study makes use of multi-method strategies for data collection. During qualitative research, the phases of data collection and analysis are interwoven and would normally occur in overlapping cycles (McMillan and Schumacher, 2006). In this study, there were three phases for data collection as illustrated in figure 5.

Figure 5: Phases of Data Collection

For this study each of the phases is meticulously carried out as follows:

Phase 1

This phase involved the selection of schools within a 15 Km radius from the district office. The researcher had to first begin by obtaining ethical clearance from the university. Once this was obtained, permission to conduct the study had to be obtained from the Kwa-Zulu Natal Provincial Department of Education allowing the researcher to collect data in the respective schools (Appendix 3). The schools that were selected were then given formal consent letters (Appendix 4) which they had to sign and were requested to keep a copy for themselves as proof thereof. The selection of instruments for data collection and piloting of these instruments were also conducted in phase 1.

Phase 2

This phase involved the beginning of data collection. The starting point for data collection was to first develop and establish a sense of trust, rapport and reciprocal relations with the participant individuals (McMillan and Schumacher, 2006). Once the researcher became familiar with the surroundings and individuals, needed adjustments on interviews and recordings were accordingly effected. Although teachers had agreed to participate in the study, some had rejected to recordings of their lessons.

Week 1 and 2

The data collection phase began with the researcher making initial visits to each school. This was to establish a degree of familiarity with the stakeholders; teacher and learners respectively. The idea was to reduce the Hawthorn Effect. The Hawthorn Effect is defined as “the tendency for people to act differently simply because they realize they are subjects in a research” (McMillan and Schumacher, 2006, p. 141). The participants were comfortable in the presence of the researcher when not teaching. However matters changed during observed classroom practices. It became the researcher's responsibility to explain the objectives of the study to these teachers to ally their fears. The researcher had to engage in initial interviews (Appendix 7 and 8) with the teacher and also obtain basic information about the individual as well as getting a vivid idea of the school setting, learners and staff. Questionnaires were used to collect data from the teachers (Appendix 9) on teacher knowledge, teacher beliefs and professional development.

Week 3

Once the initial steps to data collection as described above were achieved, the researcher had to start paying careful attention to classroom practice and learning. This was to be achieved through class visits and observations of lessons. This moment became in-depth as the researcher started to process ideas and facts that were collected during this phase (McMillan and Schumacher, 2006). A data analysis framework based on the conceptual framework of the study was developed for this phase. The data analysis framework focused on teacher knowledge, teacher beliefs and teacher professional development. This stage saw the start of lesson observations of each teacher in practice for a week during which period the teacher would meet his/her class once or twice in a day depending on the structure of the timetable.

Each teacher was considered as an individual case in this study. The findings in each case were unique. The researcher further paid attention to learner conduct and general behaviour in class. Observations were also focused on classroom learner interactions, and went also to focus on interactions between the learners and the teacher. Teaching and learning is a two way process during which new knowledge is built on existing knowledge through the process of constructivism.

Phase 3

At this point the research had drawn an end to data collection. A great deal of attention was given to possible interpretations and verifications of the emergent findings with key informants, interview responses and document analysis.

4.6.3. Data Analysis

Data analysis is an ongoing cyclical process that is integrated into all phases of qualitative research (McMillan and Schumacher, 2006). Data analysis was done using the typology approach. This involved the identification of patterns by aligning themes, categorizing research questions, use of the reviewed literature and the researchers' personal experience (Hatch, 2002). The interpretational analysis of data approach was used to examine data closely in order to find emerging themes and patterns (Gall et al., 1996).

Each case in the study was analysed individually. Unexpected patterns and categories that emerged during analysis were also incorporated. The audio interviews with each of the teachers were transcribed as precisely as possible into a word document. Since all respondents were affluent in English, the original meaning of comments were sustained. Once the transcription of interviews were completed the researcher replayed the audio and cross-referenced it with the transcription made. The researcher then transcribed all observations made for each teacher. Once this was completed the researcher began the data analysis process. The interview transcriptions, observation transcriptions as well as teacher questionnaire responses were all used simultaneously in the analysis.

After reading through the data collected and transcriptions, the coding process began. The first step required the researcher to identify themes based on the sub-research questions for this study together with the literature reviewed for the purpose. A data analysis scheme was developed. The researcher read through all the transcripts and coded the data accordingly. Figure 6 indicates the coding process of the data.

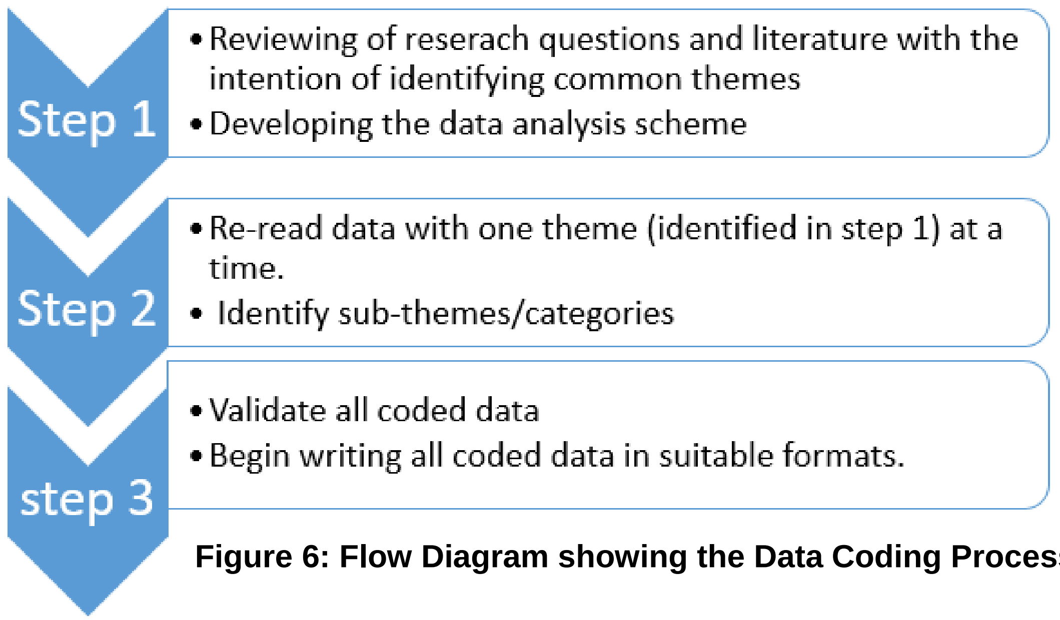


Figure 6: Flow Diagram showing the Data Coding Process

4.6.4 Data Presentation, Discussion and Findings

The data analysis scheme developed (appendix 11) was used to organize data in a tabular format. This table (appendix 11) has the themes teacher knowledge, teacher beliefs and professional development. Each theme studies the nature of the teachers' experiences and its influence on the classroom practices of the teacher. The contents of the tables were thereafter discussed and findings presented.

4.7. ETHICAL CONSIDERATIONS

The researcher sought for permission from the Department of Education at the respective district office to conduct this study. Permission was also sought and found from the University of South Africa. When a qualitative researcher conducts a study that involves human being(s), the research has to use extreme care to avoid any harm to the respective participants (Creswell and Poth, 2012).

Creswell and Poth (2012) further states that the researcher is obligated to respect the rights, needs, values and desires of the participants. Many participants did not wish to be video recorded, instead they preferred the questionnaires and/or audio recordings. After much negotiations, the teachers agreed to further provide interviews for clarity based on their responses to the questionnaires.

Confidentiality was ensured in the research through the use of pseudo names for all teachers and the schools they taught in. The consent forms clearly stipulated that the information obtained was to be used purely and solely for the current research purposes.

4.8. CHAPTER CONCLUSION

In this chapter the methodology of the study was presented. The methodology adopted for this study was used to explore the nature of teachers' experiences and how these experiences influenced their classroom practices. The next chapter presents the data from each case, discussion of the data as well as the findings of the study.

CHAPTER 5

DATA ANALYSIS, INTERPRETATIONS AND FINDINGS

5.1. INTRODUCTION

This chapter presents the data for each case, followed by the findings on each of the cases. The chapter finally presents a discussion of each case. The data for each case is transcribed under the headings of Teacher Knowledge, Teacher Beliefs and Professional Development. This study envisages to understand how the teacher's experiences on subject content knowledge, teacher beliefs and teacher professional development influence the classroom practices of each respective teacher in the subject Physical Sciences for grade 10 learners in South Africa. The study aimed to answer the following main research questions:

- What are the experiences of teachers in implementing the Physical Science curriculum in a grade 10 class?

It further sought to answer the following sub-questions of the study:

- How does the teacher's knowledge influence classroom practices in the grade 10 class?

- What is the nature of the support system with regard the professional development of teachers in grade 10 classroom practices in the subject Physical Science?

- What are the teacher's beliefs about teaching Physical Sciences in grade 10?

5.2. CASE 1: MS AVOS

5.2.1 DATA PRESENTATION

Table 3a: Key of symbols and terms for analysis of data - Case 1 Ms Avos

Symbols/Terms	Explanation
SMK	Subject Matter Knowledge includes knowledge of the content to be taught and its organization.
LPK	Learner prior knowledge is the knowledge that learners have gained in the previous grades as a prerequisite for grade ten Physical Sciences
TVT	Traditional View of Teaching teaching is done by transferring knowledge from teacher to learner i.e. teaching is unidirectional and the teacher is the main source of information (Tsai, 2002).
TAL	Traditional Approach to Learning Learning Science involves the memorization of formulae, definitions , keywords and scientific facts; and copying exactly that which the teacher does in class is acquiring knowledge from reliable sources (Tsai, 2002).
CVT	Constructivist View of Teaching Practices that allow learners the opportunity to construct knowledge (Tsai, 2002).
CVL	Constructivist View of Learning Learning Science involves constructing personal understanding i.e. learners need to be able to make interpretations and relate their prior knowledge to their experiences (Tsai, 2002).
Discipline	The manner in which the learners behave in class.
LA	Learners Apathy this refers to the learners' laziness and indifference to completing assigned tasks.
Difficulty	The challenges the teacher experiences with teaching in the classroom due to various factors.
LC	Learner Cognition this refers to the 4 stage cognitive developmental levels of learners as described by Piaget Theory of Cognitive Development.
Extensive Syllabus	The grade ten Physical Sciences curriculum covers too many topics and as a result delivery of the curriculum becomes a problem due to time constraints.

The section below present's data collected from Ms Avos.

Teacher Knowledge

Table 3.b captures the characteristics that exemplified the knowledge of Ms Avos. The focus was on the knowledge of her content and understanding of students' learning.

Key: R – Researcher MA – Ms Avos L – Learner * - Researcher note

Table 3b: Teacher knowledge - Case 1 Ms Avos

Theme	Category	Characteristics
Teacher knowledge	Content Knowledge	
		R: *The teacher indicated that she was going to be teaching "The writing of Chemical Formulae" for this particular lesson, because she was following her ATP (appendix 10) **R:** How would you begin a lesson on writing chemical formula to your learners? **MA:** (the teacher indicated she would begin her lesson by firstly asking her learners) What is matter? **R:** *The transcription below is the observed lesson of Ms Avos on writing Chemical Formulae. The transcription includes the aspects relevant to the theme. **MA:** Ok, can someone give me a definition of matter? **L:** Anything that has space and occupies mass. (LPK) **MA:** Very good. All matter is made up of atoms. Let's recall from grade nine the structure of the atom. It has protons that have a positive charge, neutrons that have no charge and are neutral and electrons that have a negative charge. (SMK, TVT) **MA:** Study my drawing on the board, the nucleus is always at the centre of the atom. And this is where the protons and the neutrons are found, and collectively we call them the nucleons. (SMK, TVT, TA-L) **MA:** Now let us go back to the periodic table. Who can give me some facts on the periodic table? (CVT) **L:** It was Dimitri Mendeleev who discovered it. (LPK) **L:** It has metals and non-metals on it. (LPK) **L:** The columns are called groups and the horizontal rows are called periods. (LPK) **L:** Group 7 elements are called halogens.(LPK) **MA:** Yes very good. Each element in the periodic table is neutral. What does this mean? **L:** It has an equal number of protons and neutrons. **MA:** Absolutely and the number of electrons an element has is the same as its number of protons which is called the atomic number and it represented by the letter Z. (SMK)

		MA: To write chemical formula it is essential that you all understand these basic concepts. Because chemical formula forms the basis of chemistry. (SMK) **R:** *The teacher handed out a worksheet to the learners that she was going to be using for the lesson (Appendix 15). **MA:** Look at the worksheet in front of you, it has a table of cations and anions. Now learners a cation is formed when any one of the metals from the periodic table gives off an electron, while and anion forms when one of the non-metals takes the electron that the metal is giving. (TA -L) **R:** *The teacher used the example of combining aluminium and sulphate as given in the worksheet (Appendix 15) to write the chemical formulae on the board for the learners. **MA:** Because a cation gives away an electron (while writing the symbol for aluminium on the board she explained further), it has a superscript plus sign at the top, and depending how many electrons it gives away you will write that as a superscript number next to the plus. (TA-L. SMK) **MA:** A similar situation applies to the anion (the teacher wrote the symbol for sulphate on the board and explained) except you put the minus sign in place of the plus and the anion takes in electrons, therefore it becomes more negative. (TA-L, SMK) **R:** *The teacher then explained to the class how to cross the superscript value of each symbol over to get the formula (indicated as e.g. 1 on Appendix 15). **MA:** These two tables (the teacher is referring to the tables in the worksheet – Appendix 15) need to be by hearted if you want to master chemistry. (TVL) **R:** *The lesson concluded with the teacher giving the learners classwork from the worksheet, and she had indicated that it would be marked in the next lesson. **R:** *The transcription below is the second observed lesson of Ms Avos on the atomic structure, this is a recap lesson on what has already been taught briefly. The transcription includes the aspects relevant to the theme. **MA:** He (Ms Avos refers to a scientist from the history of the atom) took radioactive material like? (learners give answer) Uranium good and passed it through gold foil and then? (Ms Avos wanted the learners to complete her sentences.) **L:** Particles that were radioactive went through. (Because of her wanting her learners to complete her sentences, the response was given by multiple learners simultaneously)

		MA: Radioactive particles went through, what does that mean? **L:** There is space. (again multiple learners respond at the same time, some responses were overpowered by the louder learners) **MA:** Very good there is a lot of space in the atom and some of them were deflected. What does deflected mean? (L – They bounced off. (Poor LC). **MA:** And what does that mean they bounced off? **MA:** Too many of you talking, one at a time. There was something blocking that pathway in the centre, it could not go straight through – What was that blocking it? **L:** It was electrons (incorrect response). **L:** It was proton. **MA:** Protons, so the model of the atom is then what's in the centre? **L:** Nucleus **MA:** And what is inside it? **L:** Protons and neutrons **MA:** What spins around it? **L:** Electrons **MA:** Let us discuss atomic number and mass number now **MA:** The bigger number is always the mass number and the smaller number is the atomic number. What does the atomic number tell us? (teacher writes down the symbol for lithium on the board and indicates its mass number and atomic number as a superscript and subscript respectively) (TVL) **L:** The number of protons. **MA:** How do we get number of neutrons? Seven minus 3 is four. (During this explanation Ms Avos's back was turned towards the learners and as she began to write the answer on the board, while she explained it as transcribed). **MA:** So we happy with atomic number and mass number? **L:** Yes (learners at the front of the class say yes while others say no). **MA:** Let's move onto isotopes. Who can define an isotope for me?

		L: The same atomic number but different mass. **MA:** If I gave you an example now which I am going to would you be able to work it out? **MA:** Write these examples down (the teacher writes down the examples on the board from a study guide which she has been using for the lesson). (TA – L) **R:** *Not every learner in the class had a copy of the study guide that the teacher is using. **MA:** This is still isotopes same heading as last time; you can look at the formula we used the last time to work it out. (Indicating that this section was done prior to the observed lesson) (Indicating poor learner cognition for the teacher to have to repeat the entire section). **R:** *The teacher walks around the class to identify those learners that are struggling. **MA:** If you need help raise your hand. **R:** *The lesson ended with the sound of the siren, learners by that time were still busy with their classwork. **R:** *The transcription below is the third observed lesson of Ms Avos on the atomic structure, this lesson observation took place the very next day. Ms Avos began the lesson by giving explaining the answer to the previous day classwork question on isotopes. The conversation below is some of the aspects of the third lesson that are relevant to the theme. **MA:** So you take the one mass you times it by its percentage you add it to the other mass times by its percentage all over a hundred. (TVT). **MA:** You should be quite clear on isotopes, as I told you we doing a question answer lesson today. Page 14 of the study guide those who do not have I will put it on the board but you will really have to buy it now. (The teacher did not consider the socio-economic status of some of the learners in her class). **R:** *It was observed by subtle uproar that the learners were really displeased by them being forced to have to buy the study guide. **R:** *The teacher requested that those learners who did not have a study guide, be seated next to a learner that did so they could share. She then called out the various questions numbers from the study guide that learners had to complete. **R:** *It was also observed that the learners were constantly talking and the teacher had threatened them that she

		would stop writing down the questions on the board if they did not stop talking. **R:** What would you describe as you greatest challenge in terms of implementing the curriculum? **MA:** In grade ten it is the practical lessons. There was no workshops (Ms Avos could teach the content however physically conducting an experiment based on the given content was a major problem for her). (Poor Subject Matter Knowledge for conducting experiments).
Understanding of Learners' Learning.		
		R: *The transcription includes the aspects relevant to the theme. Ms Avos indicated in her questionnaire responses that ninety five percent of her learners are African and English was not their home language. She also indicated that eighty percent of her leaners came from poor homes. **R:** *The medium of instruction for the school was English. **R:** How do you as a teacher picture a good learner? **MA:** A good learner to me is one who reads before coming to class, completes classwork and homework timeously, comes prepared for the lessons, and takes part in class discussions and attempts to answer questions. Other attributes would include good manners and etiquette. **MA:** Because my leaners are mostly second language learners, I prefer to structure my lessons with basic theory questions, as a pre-lesson homework activity. This forces them to read before coming to class and develops sort of a pre-knowledge in their mind. **R:** How often do you take the same class from grade ten into grade eleven and into grade twelve? **MA:** Ever since I was appointed here. (The teacher always took her classes up). **R:** What are your experiences when this is done? **MA:** I feel I know my learners better. We develop a good rapport and I understand their strengths and weaknesses by the time they reach grade eleven and grade twelve. **MA:** They also feel more comfortable in grade eleven and grade twelve with the same teacher. In grade ten they are new, shy and don't really actively participate in class. I guess they are still getting use to everybody and finding their feet in the subject. **R:** What skills do you want your learners to achieve at the end of the grade? **MA:** The skills as per CAPS critical thinking, become responsible citizens towards science and the

		environment, problem solving skills, applying theory to practice in everyday life. **R:** How would you describe the cognitive level of your grade ten learners? **MA:** I do recall Paigets stages of development and they are definitely not at the formal operational stage. Many still can't spell, poor grammar, poor literacy and numerical skills. (Poor Learner Cognition) **MA:** Some of the terminology to my learners are like Greek, (English is the second language for majority of the learners in Ms Avos class – Learner Language Difficulties, Poor LC) **R:** *The response of Ms Avos regarding learner understanding of words was further noted when Ms Avos during her lesson used the word "deflect" and then asked learners what this word had meant. **MA:** The learners are very lazy to read, maybe ten out of forty three will read up on their work before coming to class. (LA). **MA:** For learners of today, writing down notes is very difficult. Their spelling is terrible they very often use the shortened text in the books as they do on social media. **R:** What measures as teacher do you adopt to cater for learners with varying cognitive levels in your class? **MA:** Well when I set tests I use the CAPS document to ensure that it is a balanced paper, with the different levels of questions. **MA:** I use a lot of analogies, and also I find that with my learners incorporating their everyday life into the learning makes it more understandable to them, it become like "Aha" moment for them. (CVL) **R*:** However during lesson observations no analogies were used in the teaching of Ms Avos. **R:** In terms of learning materials what do your learners use? **MA:** Some of the learners who can afford to buy a study guide do so, but not all. Everyone however is given a text book from the school and I give them worksheets. **R:** How do you know what type of instruction to use when teaching a concept to your learners? **MA:** Well it depends on the concept, like endothermic and exothermic reactions I have to think of the safety of the learners first. I use a video simulation for the burning of magnesium ribbon (The teacher alluded to the behaviour of the learners as well as her own lack of

		knowledge on how to physically conduct such a practical.) **R:** *Ms Avos was also aware more of her learners issues of discipline rather than their prior knowledge as her responses did not give insight of her having prior knowledge of grade nine Science content. **MA:** Some learners also do not follow the rules of the laboratory, therefore I rather not allow them to do practical's instead let them watch me do some, so it is mostly observation lessons. Like some of the boys will ask if they can taste the chemicals and with a class of forty three I would rather be safe than sorry. (LA) **R:** *Based on examiners reports Ms Avos was aware of sections of work that were perceived as difficult in general by learners. **MA:** Mechanics which is very difficult is left for term three and four which is very short terms and I rush through my teaching with it. (Learner Difficulties) **MA:** Over the last three years that section of mechanics is the one that learners perform the worst in. I do not have time to go back and do revision because the exams start so soon. The syllabus in grade ten is just too long and these learners are not the brightest of children. (LCD). **MA:** The effect of this I see it in grade eleven especially in section like mechanics and vectors, then I try and spend more time there. (Difficulties) **R:** *Ms Avos indicated that when she taught sections that learners perceived as being difficult like mechanics she made use of real-life simulations. **MA:** Like when teaching vectors I use the kids and they walk in opposite directions then I explain the difference in terms used like distance and displacement, yet both use the same unit of measurement. (CVT) (The section on vectors is only taught in term four according to the ATP (appendix 10) therefore the above statement and the actions of the teacher cannot be confirmed, the teachers word will have to be taken) **R:** *While observing the teacher in class, it was seen that the teacher continued with the lesson on a new topic while leaving gaps in the conceptual understanding of some learners, it was those very same learners that had lost interest in the lesson and began to chat amongst themselves. **R:** *When the learners all responded to the teachers question simultaneously, it was observed that those responses were not a positive response to the teachers question i.e. the response was "no" instead of "yes", was ignored by the teacher and she continued to move ahead with teaching.

		MA: Because there is such a long syllabus content for grade ten and three quarters of it must be completed by the June exam (Ms Avos was following the ATP – appendix 10 and she had a textbook which she made reference to. The same text is what she always had in front of her when teaching) the learners need to be serious and not fool around in class. (time management)
Contextual Knowledge		**R:** *The transcription includes the aspects relevant to the theme. **R:** *The teaching approach of Ms Avos was monotonous and therefore the researcher tried to obtain a better understanding to the rationale of the approach used by the teacher. **R:** Do you teach Physical Sciences using the inquiry approach? **MA:** I try to incorporate inquiry teaching but with such large numbers and a lengthy syllabus it is difficult. (CVT) **MA:** When it comes to teaching a new concept because of the large class size and I prefer to just use a lecturing approach and then take questions. The group work and group discussion doesn't work. (TVT & TVL) **R:** Why do you feel such methods fails? **MA:** The desks in the lab are fixed, there is no chairs as you can see, we use benches so group work does become difficult and these learners use it as social time.(Discipline) **R:** *The issues of discipline as stated by Ms Avos in her questionnaire response and in her interviews were further observed during the class observations. She constantly had to reprimand learners for talking. Further to this she moved learners to the front of the class for not cooperating and creating a disturbance to the rest of the class. **R:** *It was also observed that during the teaching learners kept "Shhhh" each other. **R:** *The teacher on several occasions made reference to an extensive syllabus and her struggle to complete it timeously. **MA:** There are only like two really bright learners in the class. If all my students were as bright as the two I just mentioned then the time allocated for each section as per the work schedule would be fine I would definitely complete the syllabus on time, but in my school I struggle. (Extensive Syllabus) **MA:** This is the first school I am teaching at, and the learners here face many other challenges in their personal life. This does affect their focus on school.

	R: Have you ever had first-hand experience with what you have just mentioned? **MA:** Yes, some children are from very poor homes and they have to choose between a meal and bus fare to come to school. (socio-economic background of the learners) **R:** *Although Ms Avos is aware of the above, during lesson observation it was found that she still insisted that learners had to buy the study guide. **R:** Do your learners complete homework and classwork timeously? **MA:** No, very rarely the classwork. Our periods are fifty three minutes and by the time the learners move from one class to the other and then settle down a good four to six minutes of the period has passed. And like I said it takes a while for me to explain and then give them classwork. (LA) **R:** *At the start of all lessons Ms Avos always handed out a worksheet. **MA:** I prefer handing out worksheets and it saves time so I can concentrate on syllabus coverage.(Extensive syllabus) **MA:** It certainly does. Most of the time the learners are so well behaved, by that I mean there is minimal loss of time from the sound of the siren to being in class settled and ready for the lesson. It really sets the tone for a constructive lesson and the learners themselves are like conditioned to make an effort of actually understanding the lesson. And the amount of work we accomplish is really phenomenal. I can really vary my teaching styles. (Good Discipline) **MA:** Like when teaching vectors I use the kids and they walk in opposite directions then I explain the difference in terms used like distance and displacement, yet both use the same unit of measurement. (CVT). **R:** *The section on vectors is only taught in term four according to the ATP (appendix 10) therefore the above statement and the actions of the teacher cannot be confirmed, the teachers word will have to be taken. **MA:** But when the learners are badly behaved and they display a "don't care" attitude it demotivates me, and then I just use the lecturing approach. **R:** *While observing the teacher in class, it was seen that the teacher continued with the lesson on a new topic while leaving gaps in the conceptual understanding of some learners, it was those very same learners that

	had lost interest in the lesson and began to chat amongst themselves. **MA:** Because there is such a long syllabus content for grade ten and three quarters of it must be completed by the June exam, the learners need to be serious and not fool around in class. (time management) **MA:** The roll of the current grade ten class is forty three learners. The Natural Science marks of majority of these learners at the end of grade nine was between 50% and 69 %. Only two learners had 83 %. English is second language to these learners and they come from very poor homes, for them tuition is not an option. (Teacher's knowledge of learners and their socio-economic background). **MA:** All lessons take place in the laboratory, it very well displays the subject being taught. There are charts and posters. I try to make the learning environment stimulating. (CS) **MA:** For grade ten there are text books so each child will get one. The lab as you can see is very old, we do have some apparatus that can be used for some of the prescribed practicals across the grade but not all. Also some of the chemicals are so old, I am actually scared to use them. (CS) **R:** Is there a laboratory assistant to assist you with practicals? **MA:** No, I usually ask the life science educator for assistance when he is free. He usually assists during the breaks, if he is free. We attempt the practicals beforehand, but there occasions when he himself is not very sure of certain procedures and it's understandable because he is not a physics specialists. **MA:** When CAPS was first introduced, some of the practical's I had never done before. And till date I am still very uncertain of some of them. When working with chemicals it can be dangerous and the safety of the learners are priority. Also as the teacher it will be embarrassing for me if I attempted if for the first time in front of the kids and I don't know what is happening or even worse what I am doing. (PPS). **MA:** But for grade ten like I said we don't have some of the requirements to do the practical's. (UR) **R:** What happens when you do not have the required resources for a practical? **MA:** Then I usually do an investigative practical, where I will give learners a set of results and ask them to interpret it. (PPS)

	MA: The circuit practical's still confuses me. The principal helps me with the grade twelve but not ten, plus there is no one else that can really assist and we do not have grade ten workshops. (PSMK) **MA:** We write the National Papers that are set by the department and the dates are so much early than the normal exam dates that we have at our school. It's like impossible at times to give off quality teaching because there is always a rush to complete syllabus. **MA:** The class has such a large number with limited resources it is difficult to do a practical's. Practicals that I am confident in conducting I will do and let the learners observe. (UR, PDW and Demonstrations) **MA:** Some learners also do not follow the rules of the laboratory, therefore I rather not allow them to do practical's instead let them watch me do some, so it's mostly observation lessons. Like some of the boys will ask if they can taste the chemicals and with a class of forty three I would rather be safe than sorry. (LA) **MA:** Mechanics which is very difficult is left for term three and four which is very short terms and I rush through my teaching with it. (Difficulties) **MA:** Over the last three years that section of mechanics is the one that learners perform the worst in. I do not have time to go back and do revision because the exams start so soon. The syllabus in grade ten is just too long and these learners are not the brightest of children. (LCD). **MA:** The effect of this I see it in grade eleven especially in section like mechanics and vectors, then I try and spend more time there. (Difficulties) **R:** After observing your lessons a lot of them involved the question and answer approach. Are you familiar with other approaches to teaching? **MA:** Well, when I use the question and answer it involves interaction with the students and it gets them engaged and engagement is what I need. **R:** *Although Ms Avos wanted her leaners to be actively involved and engaged in the lesson, her approach only got the learners at the front of the class to answer questions.

Teacher Beliefs

Table 3c represents the beliefs of Ms Avos with regard teaching of Physical Sciences.

Key: R – Researcher MA – Ms Avos * - Researcher note

Table 3c: Teacher Beliefs - Case 1 Ms Avos

Theme	Category	Characteristics
Beliefs	**Teaching & Learning of Physical Sciences**	
		R: *The transcript below is based on the questionnaire responses, interview responses and classroom observations of Ms Avos. The transcription includes the aspects relevant to the theme. **MA:** To learn physics, I feel one has to read-up on work before coming to class **R:** Why do you believe this is important? **MA:** Because some words in physics are like Greek, especially for grade ten, learners must read to understand and have sort of a pre-knowledge and then when I explain their misunderstanding can be cleared. **R:** What methods do you use to improve your understanding? **MA:** I make use of various text books and I read up on the explanations they offer to sections. I use the internet sometimes, but I still prefer the pen to paper approach to learning. Actually writing sort of etches things in my mind. (Memorization). **MA:** Like the table of cations and anions. I literally memorized it when I was in grade ten and then tested myself by first writing out the formula next to the names and vise versa. I did this several times and I have known it ever since. (TVL) **R:** *During observations of Ms Avos, her classroom practice involved a tremendous amount of chalk and talk – she often made learners repeat after her with the aim of having them remember the procedure. It was further noted that during all lesson observations Ms Avos always worked with a study guide open in her hand. **R:** What do you understand by the term inquiry teaching? **MA:** Learners learn new things by being involved example doing practical's. (Teacher misconception of what inquiry learning is and involves.) **R:** Do you teach Physical Sciences using the inquiry approach? **MA:** No, because of the large class size in grade ten and limited equipment, I do majority demonstrations. I will ask for volunteers to come and assist. Some of the recommended and prescribed practical's I am still not very certain on how to actually conduct it so I just project a video on it. (TVT, TVL, Poor practical skills)

		R: Do you believe that the inquiry approach is an appropriate method for teaching Physical Sciences in a South African classroom? **MA:** Yes. Because I attended a grade twelve workshop held by the department at it was so interactive with the content that I don't have to look at a text book anymore for that particular section. (CVL) (Ms Avos experience of being actively involved improved her subject matter knowledge tremendously; thus making her feel that if she had similar development in the grade ten syllabus she would not struggle because she learnt how to teach the section) **R:** What do you consider to be the founding principles of teaching Physical Sciences? **MA:** As a teacher you must be passionate about the subject. Your learners must be willing to work hard and put in the extra effort. They must be prepared to read before coming to class and complete all classwork and homework. (TVL) **MA:** Physics is a demanding subject, the teacher must possess a good content knowledge, and understand the needs of his/her learners. **R:** *During lesson observation Ms Avos, did display understanding of her learners needs in terms of their conceptual understanding of terminology – she provided simplified explanations to words such as deflect – she was aware that many medium of instruction of the school (which was English) differed from the home language of the learners (majority of the learners in her class are of African). **R:** Can you describe the best teaching situation you have ever experienced as a Physical Science teacher? **MA:** In my first year of teaching I had a grade 12 class of twenty one learners, I was able to give each child the individual attention they required. The learners were dedicated, the participated in class discussions and were very well behaved. Although it was my first year of teaching I didn't mind trying out some simple experiments with these learners. They were mature and responsible (CVT and CVL)

Professional Development

Table 3d represents the characteristics on the professional development of Ms Avos.

Key: R – Researcher MA – Ms Avos * - Researcher note

Table 3d: Professional Development - Case 1 Ms Avos

Theme	Category	Characteristics
Professional Development	**Teacher Developmental Workshops for Grade 10**	
		R: What do you feel as a teacher hinders you, in your performance to teach?

		MA: There is no grade ten content workshops, so much effort is given to grade twelve, and yet none for grade ten which lays the foundation. (No TCTP) **MA:** I have tried to contact colleagues, but sometimes they themselves need assistance and don't always have the time to meet after school due to commitments. **R:** Is there anything at the school level that influences the way you teach? **MA:** Yes, I do have the support of the school management team, but that's more for discipline issues. **R:** *Ms Avos indicated that in the nine years that she was teaching at this particular school the subject advisor for Physical Sciences had made one visit only till date. **R:** What do you understand by Professional Development? **MA:** That is when a teacher is being developed in various educational aspects. **R:** In terms of your subject Physical Sciences, what do you understand by the term professional development? **MA:** Attending workshops that allow me as the teacher to be actively engaged in it, in terms of syllabus content. **MA:** this would include being workshopped on how to conduct certain practical's.(TPTP) **R:** How often in one academic year would you say you have engaged in professional development? **MA:** For grade ten there is nothing. In January we have one orientation workshop but the focus is on general items for the year (Appendix 14). There is no content recap like they have for grade twelve underperforming schools. I have not attended a workshop that focuses on grade ten content. **R:** Would you say that you are well trained in the content of the grade ten syllabus? **MA:** Not really, there are some practical's that I still do not do because I am not really sure of the procedure of it myself. Although it is given in the text, I would like to be trained on usage of the equipment and chemicals. I like to say that I am well trained but the truth is that I am not really, there are some practicals that I still do not do because I am not really sure of the procedure myself although it is given in the text I would like to be trained on

		the usage of the equipment – it would help me to do a better job (Poor practical knowledge). **MA:** Some sections like the stoichiometric calculations requires a lot of the Maths, which is not a very strong point of mine so I read up before going to class. (a need for TCTP integrating Math skills) **R:** As a teacher of Physical Sciences what kind of professional development would you like to engage in? **MA:** It would be nice to have a grade ten content based workshop at least once a year. I feel there is still so much I need to learn with the grade ten content, like in terms of mechanics and stoichiometry and if senior teachers by that I mean those who have been teaching for like twenty years can be involved in developing such workshops there is so much that can learnt from it, in terms of methodology. I like interaction, hands-on experience to be able to do it at the workshop and then go and transfer those skills to the class. (TA) **MA:** The workshop should be interactive, with breakaway sessions and also there should be workshops on how to conduct experiments with facilitators and we should physically do it in the workshops. That will allow for me to gain experience and I can get clarification and answers to the questions I may have. **MA:** The question and answer is about that best technique that I know and it works for me. **R:** Do you think professional development would help you improve your knowledge of teaching? **MA:** Yes certainly it would. I will be more confident in myself plus sections I am not sure of I just do the lecture method and a few simple activities. Because sections of work where I feel I am not very clear on the content I simply use the lecture method and give learners activities on it. Also I feel if there are such workshops then content knowledge can be improved which will also give me greater confidence to use alternate teaching methodologies during my lesson. (TA) **MA:** Having workshops that teach us a teachers how to conduct experiments, what common errors to look out for, can make my lessons so much more interesting. And if I can capture the attention of my learners I am sure issues of discipline can be eliminated, learner performance would possible improve. Such workshops will really just improve my content knowledge and skills as a teacher and

		I strongly feel it would even improve the way I teach. When people see a confident teacher, they will want to follow.(TCTP & TPTP)

5.2.2 Discussion

Teacher Knowledge
Content knowledge

Ball and Bass (2002), classified teacher content knowledge into three categories:

- *Common knowledge of content:* This is described as the everyday knowledge that all educated adults would have on the subject in question.

- *Specialized knowledge of content:* This refers to the knowledge gained through professional training and classroom experience.

- *Knowledge of content and learners:* This refers to the common misconceptions that learners may have in terms of their content knowledge of Physical Sciences.

During teacher observations, Ms Avos was teaching the section on writing chemical formulae. Ms Avos wrote down the date and the heading “Chemical Formulae” on the board. She however began her lesson by posing what sounded like an irrelevant question to the class.

> *"What is matter?”*

The teacher began her lesson with the basic principles of chemistry i.e. matter, atoms and its structure. Ms Avos started with the recall of grade nine content knowledge on "matter". Her questions included the definition of what matter was, the structure of the atoms and its contents. The lesson began with very easy recall questions. These types of questions are termed level-one[8] type questions. The learners responded by giving the correct answers and the teacher was pleased. The teacher showed happiness by saying to the learners:

> *Yes very good. Each element in the periodic table is neutral. What does this mean?*

The above response of the teacher indicated that the prior science knowledge of the learners was acceptable to the teacher. This was critical considering what Meyer (2004) postulated contending that it is important for the teacher to ascertain what the learner already knows as prior knowledge is a factor that influences learning. From the responses given by the learners Ms Avos began to structure her lesson by building on the learners’ prior knowledge gained in the previous grade's natural science.

> Ms Avos asked the learners: *Each element in the periodic table is neutral. What does this mean?*

[8] Level-one type questions: Basic recall type questions (DBE, 2013)

The researcher observed that the initial classroom practice of Ms Avos always started with a brief question and answer approach followed by predominately lecturing. Ms Avos strictly followed her ATP (appendix 10) and presented well sequenced lessons. The organization of her subject matter (for this section) was seen in how she introduced the topic and the sequencing thereafter (Kind, 2009). She drew on the content from grade nine Natural Sciences and then explained how “the atom” made up all forms of matter. As Hausfather (2001) stated, the extent and organization of the subject matter is imperative as it influences understanding of what is being taught.

Ms Avos made use of a worksheet to assist during her classroom practice. Ms Avos used the example of aluminium sulphate as given in the worksheet (Appendix 15). For many learners this example may have been a bit abstract given the fact they have probably never seen what aluminium sulphate looked like. Given the fact that Ms Avos indicated that her learners’ home language differed from the medium of instruction, it would have been fitting for her to have used the example of, say, sodium chloride because learners would have been able to relate this to their daily lives as sodium chloride is in fact the day-to-day common table-salt. Further to this, Ms Avos indicated in her interviews and response to the questionnaire that she had fear using certain chemicals. However, despite the fear, sodium chloride could have been safe to use by both teacher and learners without any threats because it was, in fact part of their day-to-day household usage. The advantages would have been that successfully used to achieve better outcomes on the writing of chemical formulae for example. In addition, this could have been sued to demonstrate to the learners how a crystal lattice in science looked like (this would have fallen under the section of chemical bonding which was too be taught under the same theme of matter and materials). Failure to do this reflected in fact that Ms Avos had inadequate knowledge for teaching, i.e. science knowledge used to carry out the work of teaching (this includes explaining concepts to learners and understanding and interpreting learners statements) science (Hill et al., 2005).

During Ms Avos' classroom practice, she made reference to the atomic number and mass number of the element as the “smaller number and bigger number” respectively. This was evidently misconception. Her limitations regarding subject content knowledge was badly exposed. However teacher preparation programmes expects teachers to have developed basic skills and a broad general knowledge of the subject (Niess, 2005). On this, I refer to what Ms Avos said in class:

> *Let’s discuss atomic number and mass number now. The bigger number is always the mass number and the smaller number is the atomic number.*

Ms Avos' subject matter content knowledge was fairly good with regard to basic content. This could have been from the fact that such content was carried over to grade 10 Physical Sciences curriculum from the Natural Sciences in grade nine. This includes the structure of the atoms, and its composition. During Ms Avos' lessons, although the questions drew on the learners' prior knowledge of their grade nine work, it did not challenge the learners' beliefs in terms of their existing knowledge on atoms, their structure and components. This is because Ms Avos immediately and abruptly declared students answers "correct" or "incorrect". Also when the teacher had posed questions to the learners based on what they might have learnt in grade nine, it was observed that the teacher did not have to constantly look at the resource (text/study guide/ worksheet) which would be in front of her for the better part of the lessons.

However when it came to grade 10 Physical Science content and expanding on the atom and integrating concepts of the atom like the writing of chemical formulae, it was observed that the teacher always had a textbook open in front of her. This was an indication that the teacher was not as confident in the subject's content knowledge as she should have been. Ms Avos would lead the learners through a question, but instead of letting the learners respond to the question on their own, she instead provided the learners with the answer. This reduced the learners into some unthinking objects in her lessons. The learners would not think for themselves, but the teacher spoon-fed them all the time there was a question to answer. In this case, Ms Avos should have been a mere facilitator who facilitates the process of learning in class. This further did not give learners the opportunity to explore discussions to alternate answers or evaluate the validity of their solutions for themselves.

Ms Avos revealed that she still need some assistance with regard certain areas of the curriculum. In fact, she said:

> *I feel like I need to be taught certain sections like the stoichiometry and the Maths that goes with it. Some prac's I still don't do because I don't know how to or I am not sure of how to use the equipment or I am not sure of the dangers of the chemicals required to be used. I feel like I need to do it with supervision for the first time because it is also embarrassing not to be able to answer questions your learners ask you about the prac.*

Evidently, Ms Avos was still lacking in some content knowledge in some areas of content knowledge. Literature (Adams and Krockover, 1997; Lee and Luft, 2008) revealed that teachers who lacked specialist content knowledge were unenthusiastic when it comes to implementing an inquiry-based teaching strategy during classroom practice. Such teachers would therefore resort to a more closed and constrained pedagogy with a high level of dependence on the textbook. As seen in the case of Ms Avos, she always had a textbook or study guide open in front of her during her classroom practices.

Secondly, Ms Avos revealed that she had difficulties with the mathematical part of the Physical Sciences as required. She had difficulty with the integrative manner expected in the teaching Physical Science as the subject would require. The fact that there was mathematics involved in the teaching of Physical Science meant that the teacher had to have appropriate subject content knowledge in both mathematics and Physical Science. This would need a teacher who is integrative and possessing multiple subject content knowledge (Magnusson et al., 1999) which Ms Avos lacked. Lack of this knowledge negatively impaired Ms Avos' subject content knowledge in Physical Science. It is a requirement that teachers possess adequate and superior subject content knowledge in their respective areas of teaching (Baumert *et al.*, 2010). Evidently, the limitations Ms Avos displayed in the subject also influenced her classroom practice strategies. For example, Ms Avos would talk the learners through the lesson; explaining the problem but also personally providing the solution(s) without really involving the learners in the identification of the problem, and also finding its solution. This made Ms Avos an ardent old school conservative predominated by the so-called "expert approach" in classroom practices (Chilembe and Bruce, 2015).

Ms Avos could identify common mistakes (such as mistaking the atomic number and the mass number) which learners would make during classroom practice. Based on this, it could be postulated that Ms Avos showed some sporadic brilliance on her subject content knowledge in this regard. This way, Ms Avos managed to extend her subject content knowledge in Physical Science which she could therefore link with learner thinking during classroom practice. She could identify learner errors and out of these emanate with appropriate corrective/coping/mitigating strategies which learners could use to deal with the errors (Ball and Bass, 2002). It was observed that Ms Avos however struggled with correct subject terminology during classroom practice. For example, she would refer to the atomic number and mass number as the “bigger number and the small number”. These misrepresentations exposed learners to learning incorrect terminology in the subject (Bayraktar, 2009).

The gaps in Ms Avos' subject content knowledge drove her to limit her teaching methods to the lecturing and the question and answer approach during classroom practice. Baumert *et al.* (2010) stated that, for teachers to be able to use a range of teaching strategies and alternative explanations that are available to them during classroom practice in their subjects, teachers needed advanced level of conceptual understanding in the subject.

Contextual knowledge

Ms Avos made reference to the socio-economic status of the learners hence not every learner had a study guide for example. Ms Avos's classroom practice was also constrained by the limited time available for teaching the subject per academic cycle. The extensive syllabus also compelled Ms Avos to resort to traditional methods of teaching - specifically the lecture method. Learners were therefore side-lined and denied that opportunity to engage in practical inquiries.

Extensive Syllabus and Time Management

When Ms Avos began her lesson she always started with a question and answer session based on the learner' s prior knowledge from previous lessons and work covered in the previous grade nine. For example, Ms Avos would pose the following questions to the learners:

- *Can someone define what matter is?*
- *Who can give me some facts on the periodic table?*

These questions are based on work covered in grade nine.

> *Could someone please explain to me what "Radioactive particles went through" mean?*

This question is based on the previous lesson. The learners successfully answered the questions. However, there was some disorder in the proceedings as learners would answer *en masse*. There was no control of this session Nevertheless, and primarily critical was that the learning process in Ms Avos' class at this point actively involved the learners in the lesson. There was observable learning through social interaction between the teacher and the learners (Geer and Rudge, 2002). When Ms Avos used the constructivist approach she created opportunity for learners to be actively involved and their learning became her primary focus (Imende, 2005). However when Ms Avos moved into the lecturing approach, her primary focus became content delivery rather than interactions. This limited learner involvement and participation. Interaction with the teacher also faded, and got relegated into the background. During interviews, Ms Avos revealed her choice for a method that primarily focused on subject content delivery was necessitated by the need and pressure on her side to complete the extensive on time. In her view, the other methods would delay her. Ms Avos in fact said:

> *The grade 10 syllabus is very long and I don't have time to go back and do revision because the exams are so early.*

Although Ms Avos handed out a worksheet to the learners, she still made extensive use of the study guide. In her questionnaire response she stated that,

> *It helps me save time and complete the syllabus on time*

However classroom observation showed otherwise, because some learners did not have their own copy of the study guide, Ms Avos still wrote out the questions on the board for them as indicated in the transcript; and writing questions on the board, followed by learners copying the questions before attempting to answer it did` take up a lot of time.

Ms Avos indicated in her questionnaire responses that the teaching aids she used included,

> *Worksheets, overhead projector and I bought my own data projector.*

Contrary to this, during observation lessons she made use of worksheets and the textbooks, no visual aids such as simulations were projected in order to aid learner understanding and learning. Bybee, Carlson-Powell, Trowbridge (2008), states that the use of such technology in the classroom can help learners become actively engaged in the acquisition of scientific knowledge and inquiry.

During the feedback sessions because of the large class size Ms Avos was unable to provide individual support to learners. The above was observed during her teaching, where the chalk and talk approach was the order of the day. It was also observed that the learners' voice of saying "no" to her question/s she posed to them was not acknowledged, when all learners responding simultaneously. As a result, the difficulty that some learners had experienced was not dealt with by the teacher. The teacher either asked the learners to call out their answers or she would personally write out the answers on the board and provide learners with the explanations of the steps as she did it.

According to Ms Avos there are days where the behaviour of learners did become highly disruptive. Such issues of discipline as described by Ms Avos in her questionnaire response and in her interviews were triangulated during the class observations. During teaching Ms Avos had reprimanded her learners for talking on several occasions, and this had not only disrupted the learning process of learners but also her teaching. As explained by Helmke (2009), when disruptions present themselves in classrooms, the teacher has to maintain order to allow for effective classroom management, as disorder impacted on the quality of instruction and of learners learning gains. Furthermore, the teacher at times moved learners to the front of the class for not cooperating and creating a disturbance to the rest of the class. It was also observed that while Ms Avos was teaching learners repeatedly uttered something like *"Shhhh"* to each other. This was to try get order back.

The disruptive behaviour of the learners impacted on the type of classroom instruction that the teacher used. Ms Avos indicated she would resort more to the lecturing approach because of poor learner behaviour, and spontaneous disruptions of the lessons. This in a way demotivated her as a teacher. Furthermore, the teacher had to contend with the extensive syllabus which she found very difficult to complete on time for end-of-the year examination within the allocated time frames. The teacher had this to say:

> *The ATP has a time slot for us to move by so by the end of a certain week I have to be finished with the section. I feel I have to follow this because of the long syllabus plus I rush at times to fit into that timeline the department gives.*

During class observations, it was seen that learners towards the far end of the laboratory would be drawing pictures in their books or copying other homework while the teacher was explaining or marking. Ms Avos maintained her role as the teacher from the front of her classroom and it was always the learners seated at the front of the class that responded to her questions. She never walked around the class and engaged with all learners during her delivery of the lesson, learning is not an individualistic process as explained by Gibbons (2002). Ms Avos teaching predominately involved the traditional view of teaching and learning. The teacher occasionally walked around her laboratory during the lesson to monitor her learner and to determine if they were all engaged in the classwork.

Ms Avos stated that the laboratory set-up was not conducive to group activities because of the manner in which the desks were set up. Learners were seated on benches that were fixed to the ground therefore being able to engage in group work would be very difficult. According to Mudau (2016), based on the constructive learning approach, learning then takes place in a social environment, however this was not happening in Ms Avo's classroom. Ms Avos remarked on this thus:

> *If we did group work I would have eleven groups, ten with four per group and one with 3 learners… groups bigger than four become too noisy and there are too many disruptions*.
>
> *When it comes to teaching a new concept because of the large class size and I prefer to just use a lecturing approach and then take*

> *questions. The group work and group discussion doesn't work.*

Ms Avos further explained she avoided group (statement b above) work because of the large class size. According to Blachford et al. (2011) when the class size is too large, learners tend to lose focus on the task because instruction is focused on the class as a whole rather than on an individual learner. Ms Avos had a total of forty three learners in her grade 10 Physical Science class. She further added,

> *I try to incorporate inquiry teaching but with such large numbers and a lengthy syllabus it is difficult.*

Konstantopoulos and Chung (2009), reiterate that in science, smaller class sizes benefit learners once they enter high school. The recommended teacher: learner ratio of secondary schools in South Africa is 1: 35 (Onwu and Stoffels, 2005).

Ms Avos described her first year of teaching and how the logistics in terms of a small class allowed her to use inquiry in her teaching methodology. However the current grade 10 class does not allow her to teach Physical Sciences using inquiry teaching,

> *Because of the large class size in grade ten and limited equipment, I do majority demonstrations. I will ask for volunteers to come and assist. Some of the recommended and prescribed practicals I am still not very certain on how to actually conduct it so I just project a video on it.*

Ms Avos further explained that although there are times she would like to use various methodology that facilitated the use of inquiry teaching, there were further challenges that faced her,

> *Lack of equipment, poor learner behaviour, lack of skills on my part in terms of conducting certain practicals.*

By withdrawing the opportunity of group work Ms Avos had unknowingly increased the challenge of learning amongst her learners in the classroom. Learners need to be given opportunities to reason and construct understanding in order for them to acquire knowledge (Nola, 1997). Ms Avos did indicate her questionnaire responses that on good days, when her learners behaved really well in class, she was able to vary her teaching methods (i.e. teaching using a constructivist approach) and therefore was able to accomplish a lot more. It is the interaction of people with each other that allows for knowledge to develop, and it is the subject teacher that is responsible for creating and supporting such learning opportunity amongst learners (Hausfather, 2001).

Teacher Knowledge of Learners Understanding

Ms Avos did try to assist her learners with their learning during her lessons. After she delivered her lessons, she walked around the classroom and provided support to learners towards the far end of the laboratory. When the teacher did this, the learners became more focused on their work, there was less talking and they continued to complete the activities.

Once the learners had completed the activities on their own and the teacher asked learners to call out the answers, Ms Avos indicated whether it was “correct” or “incorrect”. There was no discussion with learners as to where their errors or misconceptions may be therefore the teaching and feedback sessions were very unidirectional. Although CAPS which is the third generation of curriculum reform that was implemented in the year 2011 (Hofmeyer, 2010); learners are still required to be active participants in their learning process in the classroom (Dudu, 2017).

Observing the learners in Ms Avos class over a period of time, there was no active participation of all learners, it was predominately the learners at the front of the classroom that gave their undivided attention to the teacher. Because Ms Avos teaching involved a lot of the traditional methods (i.e. lecturing) she had more than often eliminated teaching practices that involved group discussion and social interactions, for reasons such as the large class size resulted in learners becoming too disruptive. By allowing for group discussions learners construct knowledge in the process of learning through social interaction and active participation with phenomena, as they develop shared meanings of phenomena (Geer and Rudge, 2002).

Ms Avos indicated that learner cognitive developmental levels were low. She stated that:

> *Many still can’t spell, poor grammar, poor*
> *literacy and numerical skills and reading skills.*

At grade 10, learners are well over the age of eleven and it from this age learners are expected to be at the formal operational stage. The formal operational stage is characterized by adult patterns of thought which involves logical, rational and abstract thinking (Piaget, 1952), at this stage learners are able to demonstrate skills of logically thinking, solving hands-on problem in logical forms, understanding reversibility, and understanding the laws of conservation (Woolfolk, 2007).

Ms Avos also alluded to the fact that some of the learners were taught by her for Natural Sciences in grade eight and nine, and they were familiar with her lecturing approach. During which she would and still does make use of worksheets that she creates from several resources. To cater for the learning needs and cognitive levels of all learners in her class Ms Avos set assessments that covered a range of cognitive levels as prescribed by CAPS for Physical Sciences (appendix A, Table 1d).

> *Set balanced exam papers and test. Try my best to explain words and concepts in ways they will understand. Use examples of daily life to explain where possible.*

Ms Avos insisted her learners read before coming to class particularly when it came to new sections of work, with the aim to have it first discussed as a class before she began to actually teach the section of work. Mortimer and Scott (2003), state that the talk between the teacher and learners in a Science classroom is fundamental to learning because it is central to the meaning making process.

> *To learn Physics I feel you have to read-up on work before coming to class, because some words are like Greek for grade 10, you must read to understand and then when I explain any misunderstanding can be cleared and they can build on their understanding. If they don't read then it makes it difficult for me to teach because they are lost with these new words.*

However this discussion was hindered according to Ms Avos when her learners did not read, and this was established by her through their non-participation. Scott (1998), describes mean making as a dialogic process during which different ideas are brought together and reflected on. The pre-reading for Ms Avos, was essential because for many of her learners English was their second language and language plays an important role in the understanding of technical terms in a subject (Van der Poll and Van der Poll, 2007).

She explained that it developed a pre-knowledge in her learners minds and by engaging with the learning material before coming to class, it allowed for a whole class discussion to take place during her lesson allowing for the meaning making dialogic process to occur. Thus allowing for her lessons to incorporate both social constructivism and radical constructivism.

So when Ms Avos started her lessons, it would always start with a few basic questions based on the homework from the previous day, followed by a lecturing approach or chalk and talk as many teachers call it. Ms Avos felt that this worked in her classroom and learners asked questions, if they were unsure of anything. Ms Avos presented the knowledge to learners in a logical sequence, according to Bell and Gilbert (1996), when a teacher adopts such a role they can be considered as experts in the knowledge. Therefore, Mudau (2013), states that a knowledgeable teacher involves learners actively in the lesson and can deal with learners' misconceptions and alternative ideas that learners' have whilst the unknowledgeable teacher adopts an algorithmic teaching style.

Teacher Beliefs

Ms Avos was very firm in her beliefs about learning Physical Sciences, due to the success she had experienced when she herself was a student. By understanding the teacher's attitudes and beliefs, her thought processes and classroom practices could be understood (Richardson, 1996).

> *When I was I grade 10 the chemical formulae I learnt by heart in a day for a test after that chemistry was a breeze for me.*

The beliefs of teachers vary and very often the fine line that distinguishes *beliefs* from *knowledge* is distorted. It is only the belief of Ms Avos that if learners memorize the table of cations and anions then chemistry becomes easy. Understanding the charge that each ion has is of importance as its relevance is related to the periodic table and its ability to react. Therefore it is important to distinguish between the two concepts. Tsai (2010), states that the experiences of teachers when they were once students impose an effect on their beliefs of teaching, and learning science. Their judgements of teaching Physical Sciences becomes clouded and as a result they fail to develop constructivist-oriented ideas about teaching and learning (Tsai, 2002).

Lehrer (1990) states that *knowledge*, has evidence to back up the claim i.e. it has epistemic standing. Whereas *beliefs*, on the other opposite end of the continuum, does not require a truth condition (Richardson, 1996). According to Feiman-Nemser and Floden (1986, p. 515) "It does not follow that everything a teacher believes or is willing to act on merits the label knowledge", as in the case of Ms Avos opinion of the table of ions.

> *The teacher must be passionate about the subject, learners must be willing to work hard and put in the extra effort and be prepared to read before coming to class.*

Ms Avos placed a great deal of emphasis on learners reading the notes before coming to the lesson, Kalman (2009), also indicates that when teachers rely heavily on notes it does not help students to develop a scientific mindset, thus creating difficulties in comprehending the Science content. Reading being imposed on learners may not always be the most effective way of getting learners to engage with the content at home and therefore can become an obstacle to the successful implementation of the curriculum (Morgan and Xu, 2011). Richardson (1996), further posits that in-service teachers to develop their thinking and classroom practices.

> Physical Science*s is not like History, there has to be an understanding of theory and then putting this theory into practice*.

According to Ms Avos responses to the questions she believed to teach Physical Sciences the teacher must have a good understanding of the content as well as understanding of the learners' capabilities. She articulated a teacher must be passionate about his/her subject. As a teacher she advocated that Physical Sciences could not be taught like subjects such as History, which involved memorization of large quantity facts. However Ms Avos contradicted herself based on her experiences of memorizing the table of ions.

Ms Avos's believed that inquiry teaching involved,

> *Learners learn new things by being involved example doing practicals.*

Firstly Ms Avos, belief of what inquiry learning is, was correct. Woolfolk (2007), defines inquiry learning as an approach in which the teacher presents the learner with a rather puzzling situation and the learner then attempts to solve the problem by collecting data and then testing his/her conclusion (Woolfolk 2007). Ms Avos believed that the initial question and answer session she started her lessons with, was her using the inquiry approach in her classroom, this was not inquiry learning. However the teacher articulates in her interviews that these sessions were in fact a pre-lesson discussion, based on the content that learners had to read. From observations of the lessons, it was only a small minority of learners that read before coming to class, and it was this small minority who were seated at the front of the laboratory that participated in the lesson.

The teachers' belief that inquiry learning could only work well with small class sizes was reiterated when she described her initial years of teaching Physical Sciences with a grade twelve class. Lortie (1975), states that to change a teacher's beliefs is often difficult to because the beliefs of teachers are based on their practical teaching knowledge that is learned over many years of classroom experience; and it is this knowledge that drives the decisions they make in the classroom. Ms Avos experienced success with a small class when she taught grade twelve Physical Science in her first year of teaching, she alluded to the use of various forms of teaching, *I didn't mind even trying out some easy experiments*

The success she experienced with a small class size influenced her perceptions and therefore her beliefs that inquiry teaching can only be done with a small class. Therefore suggesting that her positive experience with a grade twelve class with a small number of learners, was etched in her memory and this contextual factor allowed her to achieve success. However Ms Avos failed to account for the fact that grade twelve level, for any learner presents higher stakes as it is the exist level for secondary education for a learner; therefore they would automatically be dedicated and serious about their academic performance.

According to Ms Avos, Physical Science is not an easy subject and to learn Physical Sciences learners are required to put in lot of hard work, pre-reading and effort. However based on the responses to the questionnaire she alluded to learners not doing homework, learners becoming disruptive because of large class sizes and her being unable to give each learner her individual attention, and learners having low cognitive levels.

I try out easy experiments, but the class size is too large, learners at the back are so disruptive, they don't listen even if I call them to assist me.

Ms Avos was of the firm belief that pre-reading for learners was essential because,

Words in physics are like Greek, especially for grade 10, learners must read to understand and have sort of a pre-knowledge and then when I explain their misunderstanding can be cleared.

She believed that if learners did not read then her teaching would become very difficult,

When they don't read it makes it very difficult for me to teach because they are lost with these new words and then I get frustrated and then the teaching become a nightmare.

Ms Avos constantly alluded to pre-reading to being essential for the learning of Physical Sciences, because when she was a learner that is precisely what she had done and had experienced success in learning Physical Sciences. Ms Avos was so set in her beliefs she failed to realize that for her learners English was a second language; Dhurumraj (2013), and Sayed et al. (2007), state that when the LoTL (Language of Teaching and Learning) differs from the home language of learners learning abstract concepts of Physical Sciences does in fact become very difficult for learners. Physical Sciences was taught to her under the traditional approach and she is now teaching learners in a postmodern classroom under a curriculum that is underpinned by the principles of OBE which included the idea of lifelong learning and a curriculum which is based on outcomes (DoE, 1997). Ms Avos prejudged her learners because they did not read and frustrated herself.

Because of the success Ms Avos experienced as a learner herself with the traditional learning approach, she possessed the belief that her learners preference to the learning of Physical Sciences should mirror her own; and that the learners should approach the subject as she did with the same epistemological views (Gustafson and Rowell, 1995). This becomes evident with Ms Avos constant use of the traditional method of transmitting information to the learners. However Gunstone, Mulhall and McKittrick, (2009) and Schwartz and Lederman (2008), states that when teachers are unable to use explanatory frameworks to transmit knowledge of abstract concepts from Physical Sciences to the learners then the teachers resort to the traditional approach. For Ms Avos the traditional approach was the epi-centre of her belief to teaching Physical Sciences because of her own experiences of success as a learner.

Professional Development

Ms Avos understanding to professional development was given as,

> *A teacher is being developed on various educational aspects. But in terms of teaching subject, I would say attending workshops that allow the teacher to be actively engaged in it like a workshop on conducting certain prescribed practical's and actually doing it.*

The statement written by Ms Avos, *… to be actively engaged in it …* tells the researcher that the teacher in question preferred developmental workshops that allows for her to be actively involved in the learning process. According to Clarke and Hollingsworth (2002), teacher change can be described as growth or learning - during which teacher change becomes inevitably through professional activity (Clarke and Hollingsworth, 2002).

Ms Avos, indicated that in an academic year she would attend workshops, however none of the workshops were for grade 10,

> *For grade ten there is nothing. In January we have one orientation workshop but the focus is general stuff for the year. No content recap or stuff like they have for grade 12 under-performing schools – grade 10 has none.*

Although Ms Avos was teaching for several years she felt she still required development in the curriculum (appendix 9),

> *Not really, some practical's I still do not do because I don't know how to. I don't feel safe using the chemicals. Some sections like stoichiometry I have to read and understand first because the math is a bit difficult.*

Ms Avos struggled at times with the Mathematics that was involved in Physical Sciences. In terms of her content knowledge, she was very well versed in some sections, however she indicated that at times in other sections she struggled. When professional development focuses on subject-matter knowledge and deepen teachers' content skills (Cohen and Hill, 1998), it then allows for teacher knowledge and skills to be enhanced (Guskey, 2009).

> *Having workshops that teach us a teachers how to conduct experiments, what common errors to look out for, can make my lessons so much more interesting. And if I can capture the attention of my learners I am sure issues of discipline can be eliminated, learner performance would possible improve. Such workshops will really just improve my content knowledge and skills as a teacher and I strongly feel it would even improve the way I teach.*

Ms Avos felt that professional development in terms of experiments were essential i.e. Teacher Practical Training Programmes (TPTP). It would not only improve her knowledge but also her teaching as Duncal et al. (2007) explains professional development not only impacts on teacher knowledge but also results in improved classroom teaching which links itself to an increase in learner achievement. During the lesson observations of Ms Avos, no practical lessons were conducted for the section of work being taught, although the Annual Teaching Plan (Appendix 10) did allocate time for a "Recommended Experiment (Informal): Do flame tests to identify some metal cations and metals (Informal)", however this was not done.

She further explained that when it came to teaching combustion reactions, she did not use any experiments such as the burning of magnesium ribbon, because this was an experiment that she had never done before and she had to put the safety of her learners first.

> *Endothermic and exothermic reactions I use the data projector to show the burning of magnesium ribbon because I was never workshopped on*

> *doing the practical and I am not sure how to do it myself and I have to put the learner safety first.*

Ms Avos's lack of practical knowledge not only impacted on her teaching but also demotivated her at times, and this was evident in her questionnaire response,

> *It is embarrassing to be unable to answer questions that your learners ask you when conducting a practical, like the how, why and what happens.*

According to Badasie (2014), by providing teachers with required support through professional development programmes it would not only provide teachers like Ms Avos with job satisfaction but also help many teachers in a similar position as Ms Avos to cope with problems such as poor discipline, large classes and the huge subject demands placed on them. However such support cannot be once off, it has to be continuous and intensive (Smylie, Bilcer, Greenberg, and Harris, 1998; Hawley and Valli, 1999).

The teacher in question clearly is in need of assistance, and has made efforts to ask for help, however based on the responses that Ms Avos received when she asked for help from colleagues, it is evident she is not alone in experiencing such problems,

> *I tried to contact colleagues but sometimes they themselves are confused and don't have time to meet due to other commitments after school.*

Due to the lack of professional development in grade 10, Ms Avos felt that she was not equipped to adequately deliver the curriculum,

> *We don't have grade ten prac workshops...my pracs are more investigative I give the learners a set of results and ask them to interpret it.*

Thus based on the responses of Ms Avos, it can be deduced her practical lessons, are in fact a theory lesson because the learners are not physically engaged in doing an experiment, they are merely interpreting results. Studies by Anthony and Walshaw (2009); Drake, Spillane and Hufferd-Ackles (2001); Jita and Ndlalane (2009); and Zakaria and Daud (2009), all advocate that for teachers of science to be successful in their classrooms they need to be proficient in the content and methodology of the subject. Ms Avos was not skilled in conducting some of the prescribed experiments (as stated in the ATP, appendix 10) for Physical Sciences therefore the development of the required scientific skills in learners would have not been achieved.

Ms Avos was very keen on attending professional development workshops because she was of the belief that it would improve not only her content knowledge but also her classroom instruction. Because high quality professional development are structured in a manner that immerses the teachers in inquiry, questioning, and experimentation and therefore models inquiry forms of teaching (Supovitz and Turner, 2000). Ms Avos indicated when there was a lack of knowledge then she would resort to the lecturing approach during her teaching. She alluded to ideal professional development workshops that would allow for teachers to be actively involved in group work, physically conduct experiments and followed by analysis of the results and discussions.

Thus Ms Avos would have liked professional development workshops that ultimately allowed for the collaborative interaction of teachers. Research studies by Anderson (2007); Bolam, McMahon, Stoll, Thomas, Wallace, Greenwood, Hawkey, Ingram, Atkinson, and Smith, (2005); Christie (2005); DuFour (2004); Johnson (2009); and Pappano (2007) posits that such professional development acts as a mean to build on teachers' knowledge and skills and thus positively impact on student learning. Professional development therefore serve as a medium for the promotion of conceptual change in teachers and such change according to Asoko (2000), is essential in teaching Science.

5.2.3 Findings

The outcomes of this study are to understand how the experiences of the teacher influence classroom practice in grade 10 Physical Science. The outcomes are reported as follows:

TEACHER KNOWLEDGE

Ms Avos's content knowledge on the basic concepts of the section of Matter and Materials (which is taught in grade nine Natural Science) allowed her to question learners and probe into their response thereby creating opportunity for the scaffolding of learning. When she began her lesson on writing chemical formulae she started with a recall of prior knowledge that learners would have gained in grade nine Natural Sciences. The teacher therefore displayed good organization of her content knowledge.

Ms Avo's classroom practice predominately focused around the traditional view of teaching grade 10 subject matter content knowledge. The teacher used an expert style of teaching only in the classroom. She lectured to her learners thus her classroom practices left no room for learners to think critically or question phenomenon. With the lecturing the teacher posed questions to her learners and immediately answered them herself. The researcher infers that because Ms Avos was not well versed in her grade 10 content knowledge providing answers to her learners she avoided discussion between herself and the learners as she may not have wanted to be placed in a situation that would have been embarrassing for her as the teacher.

Ms Avos had limited practical knowledge (i.e. being able to physically conduct experiments in class with learners, awareness of common errors that can occur when conducting experiments, and being knowledgeable of learners errors and misconceptions when conducting practicals) created challenges for her as the teacher. Consequently the development of the required scientific skills as stated in the CAPS document would have not been achieved. Ms Avos's lessons were limited to lecturing and a few question and answer sessions. As a result not all learners were involved in the lesson. This lead to issues of poor discipline in the classroom.

BELIEFS

The memorization of the table of ions rather than understanding the manner in which ionic charges were derived was perceived to Ms Avos as being the best way to learn how to write chemical formulae. This was because of the manner in which it was taught to her as a learner during which the *status quo* was the traditional method of learning. Consequently the beliefs of Ms Avos towards the learning of Physical Sciences influenced the way she taught the subject. Ms Avos was never given the opportunity to challenge her beliefs (there has been no grade 10 professional development that has focused on subject matter knowledge) about teaching Physical Sciences.

Ms Avos believed that if she engaged in classroom practices such as group discussions, it would be an opportunity for her learners socialize. Thus no learning would take place. Consequently Ms Avos did not believe in learning by social constructivism. The researcher infers that in order to change the beliefs of Ms Avos, professional development workshops that cater for the needs of the teacher for the given grade needs to be implemented.

PROFESSIONAL DEVELOPMENT

Ms Avos was not exposed to professional development that focused on grade 10 Physical Sciences. Consequently the lack of professional development for a novice teacher like Ms Avos influenced her classroom practices. Thus a lack of professional development for the teacher resulted in a vicious circle of the *status quo* as shown in the diagram below.

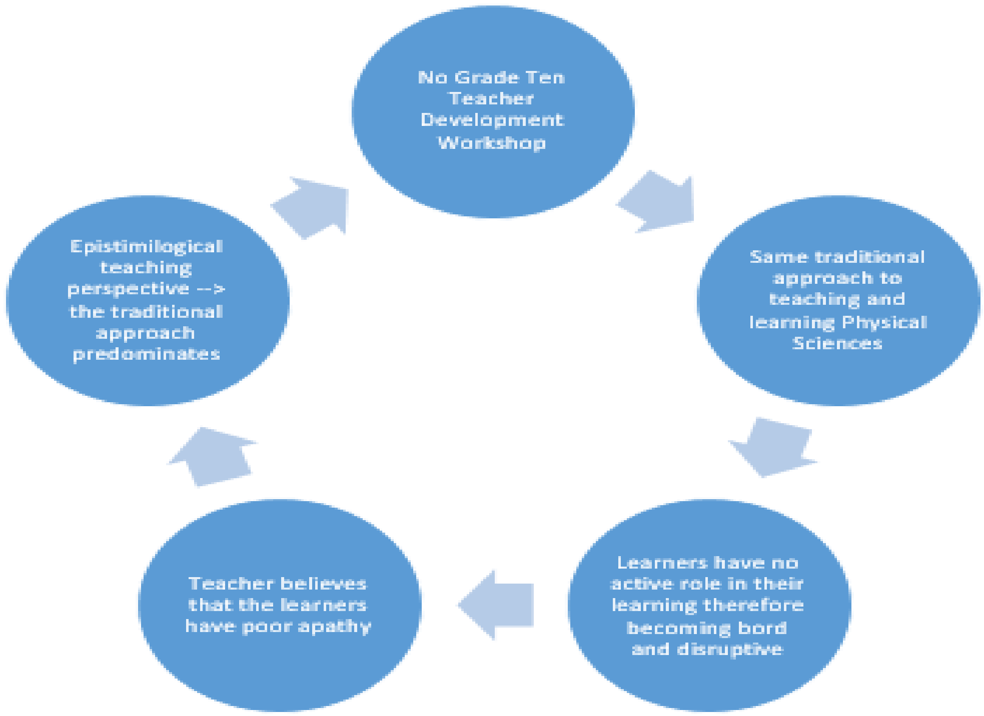


Figure 7: Diagram showing the cyclical nature of No Grade Ten Developmental Workshops on the classroom practice of Ms Avos

A lack of professional development resulted in Ms Avos's PCK being poorly developed. Subsequently learning had no meaning to some learners therefore leading to boredom and disruptions in the classroom. The teacher believed that her learners were being disrespectful. However Ms Avos failed to realize the learners were becoming disruptive because they were not involved in the learning process. Thus the status quo of learning Physical Sciences through traditional teaching remained.

Studying the Venn Diagram below (Figure 8), based on the data collected from Ms Avos her experiences due to a lack of professional development that focused on the grade 10 Physical Sciences curriculum impacted on her classroom practices that she adopted in her classroom; it further impacted on her beliefs because of her teaching methodology being deeply rooted in the traditional view of teaching and learning Physical Sciences. This then impacted on her teacher knowledge, which meant limited pedagogical content knowledge. As a result of this her classroom practices did not facilitate the development of skills such as problem solving, inquiry and critical thinking which implies a failure to promote the end which is meaningful learning. Therefore a strong relationship existed with a lack of professional development and the kinds of teaching practices that Ms Avos used in her classroom.

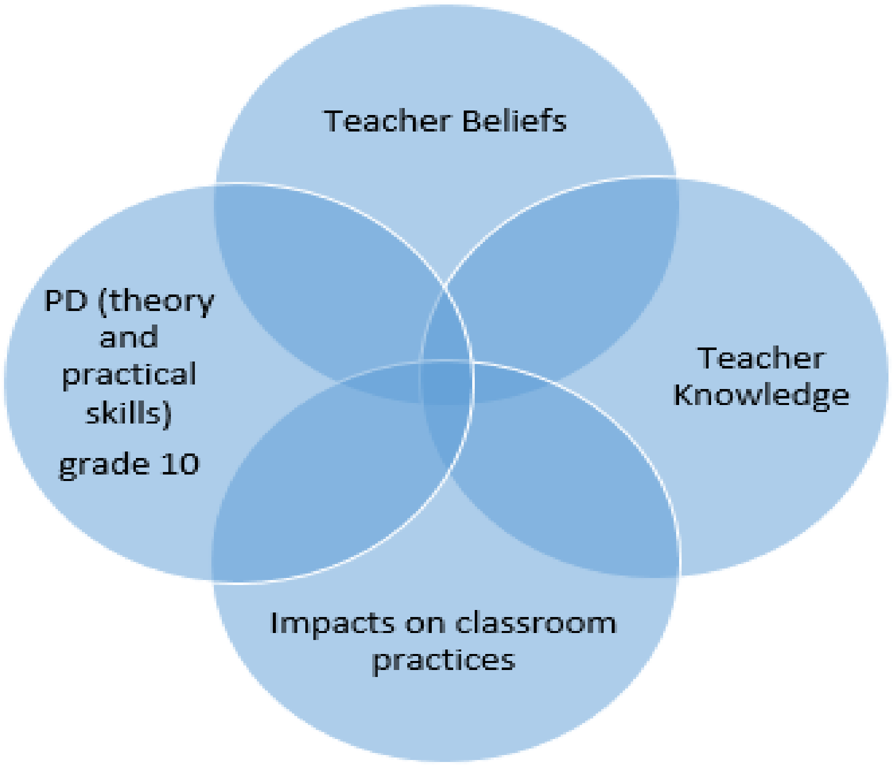


Figure 8: Venn Diagram of aspects impacting on Ms Avos Classrrom Practice

The researcher infers that a lack of Professional Development (PD), can be considered the very basic factor that impacted on Ms Avos's experiences. Thereby influencing her classroom practices. A lack of professional development impacted on her Teacher Content Knowledge (TCK) which cascades onto her Pedagogical Content Knowledge (PCK[9]). This further cascades onto her beliefs.

Further to the professional development programmes focusing on Physical Science content and skills, it is necessary for content that relates to the general to areas outside of Physical Sciences for example the aspect of Math, which is required in the teaching of Physical Sciences be covered. Although Ms Avos possessed academic qualifications to teach Physical Sciences she was unable to apply the pedagogical knowledge that she had gained through her qualifications to the teaching of Physical Sciences in the classroom. Ms Avos therefore preferred keeping to classroom practices that gave her more confidence. Because Ms Avos was never exposed to continuous professional development for grade 10 Physical Sciences conceptual change for her as a teacher would have been difficult.

The researcher infers that for the case of Ms Avos her experiences (experiences in her teacher knowledge, beliefs of learning and professional development) as a

[9] Pedagogical Content Knowledge (PCK) is the transformation of several types of knowledge for teaching (including subject matter knowledge), and that as such it represents a unique domain of teacher knowledge. (Magnusson *et al.*, 1999).

teacher influenced her teaching in a manner that was clearly not developing scientific skills that CAPS envisions learners to achieve at the end of grade 10 Physical Sciences. The impact of such practices will be cascaded into grades eleven and twelve because the learners would have not achieved the basic foundation they require from grade 10 for grades eleven and twelve. This would also impact on the teacher's delivery of the curriculum (the teacher may have to re-teach grade 10 concepts and this will affect the time frame for syllabus completion); and the learner's performance in Physical Sciences because of a poor conceptual understanding of the abstract concepts.

5.3. CASE 2: MS SASSY

5.3.1 Data presentation

Table 4a: Key of symbols and terms for analysis of data - Case 2 Ms Sassy

Symbols/Terms	Explanation
SMK	Subject Matter Knowledge includes knowledge of the content to be taught and its organization.
LPK	Learner prior knowledge is the knowledge that learners have gained in the previous grades as a prerequisite for grade ten Physical Sciences
TVT	Traditional View of Teaching Teaching is done by transferring knowledge from teacher to learner i.e. teaching is unidirectional and the teacher is the main source of information (Tsai, 2002).
TAL	Traditional Approach to Learning Learning Science involves the memorization of formulae, definitions, keywords and scientific facts; and copying exactly that which the teacher does in class is acquiring knowledge from reliable sources (Tsai, 2002).
CVT	Constructivist View of Teaching Practices that allow learners the opportunity to construct knowledge (Tsai, 2002).
CVL	Constructivist View of Learning Learning Science involves constructing personal understanding i.e. learners need to be able to make interpretations and relate their prior knowledge to their experiences (Tsai, 2002).
Discipline	The manner in which the learners behave in class.
LA	Learners Apathy this refers to the learners' laziness and indifference to completing assigned tasks.
Difficulty	The challenges the teacher experiences with teaching in the classroom due to various factors.
LC	Learner Cognition this refers to the 4 stage cognitive developmental levels of learners as described by Piaget Theory of Cognitive Development.
Extensive Syllabus	The grade ten Physical Sciences curriculum covers too many topics and as a result delivery of the curriculum becomes a problem due to time constraints.

The section below presents data collected from Ms Sassy.

Teacher Knowledge

Table 4b captures the characteristics that exemplified the teacher knowledge of Ms Sassy. The focus was on the knowledge of her content, her contextual knowledge and her understanding of learners' learning.

Key: R – Researcher MS – Ms Sassy L – Learner * - Researcher note

Table 4b: Teacher Knowledge - Case 2 Ms Sassy

Theme	**Category**	**Characteristics**
Teacher knowledge	**Content knowledge**	
		R: *The transcription includes the aspects relevant to the theme. **R:** *The teacher had indicated that the lesson she was going to be teaching was the history of the atom. Prior to the observed lesson learners had been partnered up and assigned the task of researching the discovery made by different scientists on the atom. **R:** *The lesson began with learners presenting their work. After each group presented the teacher elaborated on their presentations by making reference to essential points. The lessons began with the first discovery made by John Dalton, followed by consecutive discoveries of the atom by other scientists. **MS:** The Billard ball model, is just a solid sphere, would you accept something like that from us today? If I tell you the atom is solid; how did you study the atom last year? (no learner responds to the teacher, so the teacher presents a follow up question) **MS:** What do you know about the atom from last year? **L:** Smallest particle. (learners prior knowledge) **MS:** Give me something about the structure of the atoms? (CVT) **L:** It has sub-atomic particles. **MS:** What are the two parts of the atom? **L:** Electrons (learners only mention one part, indicating poor prior knowledge)

		MS: The nucleus and the electron cloud. And what do we find in the nucleus? (the teacher gave the correct answer) **L:** Protons and neutrons (all learners responded simultaneously) **MS:** And what do we find in the electron cloud. **L:** Electrons. **MS:** does he (Dalton) have anything like that in his model? **L:** No **MS:** No, so that is why we could not accept this (referring to Dalton's Model) as an atom. Right next two (the teacher refers to the next group of learners that were required to present). **R:** *Several groups make their presentation, thereafter the teacher makes the comment below. **MS:** All of you missed the boat. (Learner Misconceptions – the learners failed to speak of the discovery made by each scientist instead they gave biographical information, of each scientist) **R:** * It was observed that all learners that had presented had not spoken about the discovery made by the relevant scientists and its relationship with the atom. **R:** *The teacher provided a detailed explanation of the discovery made after each group had made their presentation. **MS**: With the Crooks tube he (James Crook) found that there was a little cross in the centre and you are just passing electrons from one side to the other but when that was done he found that the little cross in the middle began to rotate. This was the electrons. (Good SMK, TVT) **MS:** Before this discovery Faraday discovered there were charges, but he didn't know they were positive and negative as such he just discovered the electrical nature of matter. (Good SMK and good organization of SMK) **R:** *The teacher makes reference to an experiment that demonstrates that matter has charges and explained the details and results of it. This experiment would have been done in primary school. Learners had no

		knowledge of such an experiment. (Poor learner prior knowledge). **MS:** The atom is like a hot cross bun, if you cut up the hot cross bun do you find all the raisins at the bottom? (Use of analogies) **L:** No. **MS:** They are all over the place, so just like that the atom was a solid sphere but with positive and negative charges all around the place and we call this the current bun model. (Good SMK) **MS:** But why will we not accept this model? Because electrons are on the outside and protons in the centre of the atom. So what is still missing in the atoms? (Learners prior knowledge) **L:** Neutrons. **MS:** Ok, great who is next? **R:** *The next group of learners go to the front of the laboratory to present their work. The lesson continued in this manner until the end of the period. **R**: How do you structure your lessons? **MS:** I start with a bit of the theory first, in the introduction, make it as simple as possible I repeat and I tell them I repeat so listening to it for the second time, they replay in their minds and so you learn a bit extra and sort of grasping the content. (Organization of content) **MS:** Then I use the board just to put down summaries, but I also give them proper notes with proper definitions and stuff and then I carry on with the next bit. I do not do a whole chunk of theory at a time, it is broken up and if there is calculations then it also comes in.
	Context knowledge	**R:** *The transcription includes the aspects relevant to the theme. **R:** What is the role of your grade ten class? **MS:** There are forty two learners in the class, it is difficult to see to every learners needs; when I had smaller classes like thirty is was easier you pay more attention to the learners (Teacher difficulties - with a large class size, the teacher experiences problems with learner discipline).

		R: What are some of the hindrances that you have experienced as a teacher of Physical Sciences? **MS:** Disruptive behaviour (from the learners) **R:** How have you addressed this? **MS:** We try to win them over. Disinterested learners we try to get them to learn all their rules and their laws so at least they make that thirty percent to pass. The level one and two questions they will be able to answer. **R:** *The transcription below is from a lesson observation during which the teacher had problems with learner discipline. **MS:** If you (learners) do not like the rules in the class go to the other class. (Learner discipline) **R:** *While learners were presenting learners seated in the very last row constantly engaged in their own personal conversations which disrupted the lesson. **R:** What teaching aids do you use to deliver lessons? **MS:** We use power points and a white board. **MS:** We do have equipment for experiments but we would prefer to have more availability of new equipment (equipment available is old and outdated) **R:** Do you have all the resources you require to conduct the practical lessons? **MS**: No not all the resources, sometimes we get it (videos of the practical) downloaded from the internet and we play it to them and then we discuss it to them (learners), and that brings it more into light with them instead of not doing it all. (Limited resources) **R:** What would you describe as your greatest challenge in terms of implementing the curriculum? **MS:** CAPS curriculum is too long. Time is not a luxury we have, the grade ten syllabus is very long and when it comes to doing the bigger topics it's difficult to get them to understand and work the way we actually want them to. (Time Management). **MS:** We need a lot of time to practice the bigger topics like mechanics. (Time management).

		MS: School activities, such as gala, sport and its training result in time lost. **MS**: A lot of them do not get to do the research because maybe they don't have the stuff at home. (Socio-economic background of learners).
	Learner Knowledge	**R:** *The transcription includes the aspects relevant to the theme. Ms Sassy indicated in her questionnaire that her classroom demographics for her learners were fifty percent Black, forty five percent Indian and the remaining five percent included both Coloured and White learners. **R:** How would you describe the cognitive level of your current grade ten learners? **MS**: They are not mature enough for grade ten Physical Science. They answer in everyday language instead of scientific terminology, especially in term 1 and term 2 (teacher refers to the school terms). Towards the latter half of the year they mature. **MS:** They are not that in to it. You see grade eight and nine we find that they are not moulded into creative thinking, deciphering things, they are spoon fed. So now they have to think and work things out for themselves. **R:** Do you feel your learners are mature enough to learn Physical Science **MS:** When learners come to grade ten they feel that Physical Sciences content is very similar to the Natural Sciences, which is not a high keyed pathway. (Poor learner abilities). **MS:** Learners still use the simple terms they don't answer in the proper scientific manner, and it takes us time to get (the learners) into that habit of answering in that manner. There are specific rules and laws that have to be applied and they can't do it, which is unacceptable. They give you off the cuff answers. (Poor learner cognition). **R:** What measures do you as a teacher adopt to cater for the learners with varying cognitive levels in your class? **MS:** Explain in simple language, go over concepts many times, do examples on the board, followed by a written summary on the board and then drawings.

		R: Do all your leaners complete homework and classwork on time? **MS:** Lots of them but you do have your shirkers as you saw in today's lesson. (Learners were require to research in groups of two on the different scientists and explain their discovery they had made, a minority did not do the homework, while some relied solely on their partner and made no contribution.) **R:** Does the attitude of the learners influence the way you structure your lessons? **MS:** Yes, if learners are enthusiastic and respectful I go the extra mile and make sure the learners understand the lesson, I will find alternative ways of trying to put the subject matter across to them. (The teacher attempts to improve her PCK). **R:** Do you teach Physical Sciences using the inquiry approach? **MS:** Scientific inquiry not used all the time, but most of kids are not in that inquisitive idea way of things, they just listen to watch you saying. (Poo learner abilities) **R:** Are your learners equipped to cope with the grade ten Physical Sciences and the Math? **MS:** It is a bit difficult in the beginning, they find the changing of the subject of the formula difficult. Also the English is a bit difficult, they have to read to understand so it takes us a bit of time to groom them. (Learner Difficulties, Poor prior knowledge).

Teacher Beliefs

The table below represents the beliefs of Ms Sassy, in terms of her teaching of Physical Sciences and her grade 10 learners who are studying Physical Sciences. The table below indicates the responses of Ms Sassy to the interviews (Appendix 7), questionnaire responses (Appendix 8) and classroom observations (Appendix 5 and Appendix 6).

Key: R – Researcher R* - Researcher Note MS –Ms Sassy L – Learner

Table 4c: Teacher Beliefs - Case 2 Ms Sassy

Theme	**Category**	**Characteristics**
Beliefs	**Teaching & Learning of Physical Sciences**	
		R: *The transcript below is based on the questionnaire responses, interview responses and classroom observations of Ms Sassy. The transcription includes the aspects relevant to the theme. ***R:*** **The teacher had indicated that the lesson she was going to be teaching was the history of the atom. Prior to the observed lesson learners had been partnered up and assigned the task of researching the discovery made by different scientists on the atom. (Constructivist view of teaching)* ***R:*** **The lesson began with learners presenting their work. After each group presented the teacher elaborated on their presentations by making reference to essential points. (Constructivist view of learning).* ***R:*** **The transcript below is part of an observed lesson of the teacher* **MS:** The Billard ball model, is just a solid sphere, would you accept something like that from us today? If I tell you the atom is solid; how did you study the atom last year? (no learner responds to the teacher, so the teacher presents a follow up question) **MS**: What do you know about the atom from last year?

		R: What in your opinion is the best way to teach Physical Sciences? **MS:** Teaching Physical Sciences requires a lot of explanation together with everyday example, bring in more power point presentations, just to make it more understandable to the learners, so they can visualize and make the topic more understandable (Use of technology and analogies). **R**: Do you feel you are well trained in the content of the grade ten syllabus? **MS**: Yes, I have been teaching for many years. (The teacher's own years of teaching have thought her that which she needs to know – there was no formal training. **R:** What do you understand by the term inquiry teaching? **MS**: I think would be more asking the children to do the research and go and inquire about things and then come in and we put it together into the right context. (misconception) **R:** Do you feel you are using the inquiry approach in your classroom? **MS**: We use but not on every topic, and not every time but we do use it every now and then, like when a topic lends to everyday life, like Newtons Laws, the Doppler Effect and Change in Phase. (It is only the last section- change in phase - that is part of the grade ten syllabus) **R:** *The teacher makes reference to content and inquiry being relevant for it to be used but earlier the teacher spoke of the learners not having an inquisitive mind under the teacher knowledge of learners hence she did not use it often. **MS**: Topics like electron configuration and afbau diagrams does not lend itself to the inquiry method.

		R: What do you consider to be the founding principles of teaching Physical Sciences? **MS:** As a teacher you have to be dedicated to getting that work done, you want to see child prosper and do well and succeed. I go out of my way, even if I had done it three times and someday asks me mam please explain that again and I can see the eagerness in them. (*Repetition* is indicative of initial teaching approaches that was traditional, thus suggesting that learners were not involved in the learning process hence they did not assimilate the knowledge/information given to them) **R:** What are your views on grade ten content knowledge development for new teachers? **M**S: Novice teachers need to have a greater content to teach the subject and that will also give them more confidence in the classroom. If a teacher who doesn't know much comes in, they themselves have a hard time understanding the content and then putting it across to the children will be far worse. **MS:** When I first started teaching I had a junior class and another senior teacher took the senior class and mentored me, and showed me the pathway. (peer teaching, SMK) **R:** Can Physical Sciences be taught like subjects such as History and Business Sciences? **MS:** No, those are more story telling subjects. The approach with the content is very different for Physical Sciences. (TVT) **R:** Can you describe circumstances that have prevented you from using the inquiry approach in the class? **MS:** Eagerness of the child, not that eager about getting the work done using the inquiry manner, they prefer us to just give them everything. (LA)

		MS: Across the grades learners expect to be spoon fed. **MS**: When learners go for tuition they come to class with a sort of background knowledge, so those lessons go smoothly. **R:** Can you describe the best teaching situation you have experienced as a Physical Science teacher? **MS**: More towards the end of the year when I do topics like mechanics and other topics like writing formulae and how to obtain a formulae, get them to understand those calculations and bond numbers and the cross-road method when writing chemical form, those topics really does give me a good feeling because you can see they understand. (Process View Teaching and Process View Learning) **R:** What do you believe is a good Physical Science Learner? **MS:** A good learner pays attention, respectful and humble, and one that's actually understands the work and goes home and tries the work irrespective of the child being A, B, C or D candidate. The fact that the child is trying for me is important. (Learner initiative). **MS:** In Physics we make the learners self-sufficient, and develop critical thinkers. **R:** Does the attitude of your learners influence your beliefs on how you should structure your lesson? **MS:** It does, if I find that the learners are very keen, then we can get more done in that particular time. Then you also find the others that are disturbing the lesson and that sort of pulls us back a bit. So it's hard we have to be in the centre we can't go too fast or too slow with the lesson. (Teacher must make use of a variety of approaches)

Professional Development

The table below represents the Professional Development of Ms Sassy, in terms teaching and her learners. The data indicated are the responses of Ms Sassy to the interviews (Appendix 7), questionnaire responses (Appendix 8) and classroom observations (Appendix 5 and Appendix 6).

Key: R – Researcher R* - Researcher Note MS – Ms Sassy

*T*able 4d: Professional Development - Case 2 Ms Sassy

Theme	Category	Characteristics
Professional Development	**Teacher Developmental workshops for grade ten**	**R:** What do you understand by professional development? **MS:** Attending workshops that make us aware of better and easier approaches to teaching the topics, and make us aware of what the current field is looking at. **MS:** Development of educators to perform better in class (teacher's questionnaire response). **R:** How often in one academic year would you say you have engaged in profession development? **MS:** Approximately 5 times in a year (this includes development at the school and subject specific workshops the teacher attends) **R:** Does any of the professional development initiatives you attend focus on grade ten Physical Sciences? **MS:** No, emphasis is in grade twelve work. **MS:** The grade ten educator does not go for the professional development. We don't really have one for grade ten. Only when CAPS was introduced the grade ten teachers went. **R:** Do you have visits from your subject advisor? **MS**: In the past yes there use to be a lot of visits but recently there has been no visits, he use to come a look at the books and the pacing of the syllabus. **R:** In one academic year how often would you say you have engaged in professional development for Physical Sciences? **MS:** Maybe once. (Uncertainty) **R:** What kind of professional development would you like to engage in? **MS:** Workshops that show you different techniques for teaching and types of questions that can be tested. Because with Science a topic can be tested in so many different ways in a paper. (PI) **R:** Are there any content workshops for grade ten?

		MS: No, teachers are expected to set the tone in grades ten and eleven, and only in grade twelve they would call us in to up our game. **MS:** There is a need for workshops in grade ten because if there is a novice teacher then they need to know the requirements, how far to go with the teaching, although it is written down, they need the guidance. **R:** Do you think professional development would help improve your knowledge of teaching? **MS:** It would improve my method of approaching a topic and introducing content to learners. **R:** Are Physical Science practical skills important for novice teachers? **MS:** Yes they should, because they are going to have to show the learners the different pracs that we are required to do. **MS:** There are no practical developmental workshops for grades ten, eleven and twelve. **R:** Do you feel practical development workshops would enhance your teaching? **MS:** Yes, yes it would really. I may be doing the practical and it maybe not a hundred percent correct or I could be doing it incorrectly. (teacher lacks confidence in her practical skills) **MS:** It would definitely help to have a prac workshop. **R:** How would you structure a grade ten workshop? **MS:** I would look at more application of the content knowledge, types of activities that they should use when teaching, explain practical and how to conduct it, provide the teachers with guidelines on how to do the practical's and the CASS pieces and how to prepare learners for the exams. (Teacher needs)

‘’

5.3.2 Discussion

Content Knowledge

Content knowledge is the amount and organization of subject matter knowledge in the mind of the teacher. During the teacher's presentation of her subject matter it was noticed that Ms Sassy in fact had a good understanding of the theoretical content. Ms Sassy was familiar and confident in her knowledge of the content to be taught, the teacher was able to deliver her lesson without making constant reference to a text book or worksheet. The teacher's ability to teach without the use of any resource material in front of her is indicative that the teacher possesses good subject matter knowledge, which permits for meaningful learning to take place (Ramnarain, 2013). Ms Sassy said:

> *I am well trained for the content of the grade 10 syllabus because I have been teaching for a long time, and even when the syllabus changed (it moved from NCS to CAPS) it was topics from grade eleven that came into grade ten, so it was ok.*

When the change from NCS to CAPS was effected topics in the Physical Science curriculum had moved around, for example empirical and molecular formula calculations which was previously taught in grade eleven had to now be taught in grade 10. Hashweh (1987), posits that teachers who are more knowledgeable of their topic as in the case of Ms Sassy, have better ways representing the knowledge in the classroom; hence Ms Sassy did not follow the textbook structure to deliver the lesson.

The organization of her subject matter was seen in how she introduced the topic and the sequencing thereafter (Kind, 2009). According to Hausfather (2001), the extent and organization of the subject matter is important because it influences the development of understanding in learners. When she called her learners to present their findings she started with the group that was presenting the initial discovery made of the atom and then the consecutive discoveries followed.

When Ms Sassy corrected her learners she did so by making reference to their prior knowledge and then building on it. According to Hausfather (2001), learning involves the connection between prior knowledge with new information. Ms Sassy asked her learners:

> *What do you know about the atom from last year?*
> *Give me something about the structure of the atom?*
> *Learner response: It has sub-atomic particles*
> *What are the two parts of the atom?*

Such organization of the teacher's subject matter knowledge was essential as it shaped (Kind, 2009) how the teacher had presented the content matter to her learners. In addition, the teacher made reference to an experiment, which learners would have conducted in primary school; the experiment she made reference to demonstrated that matter has charges. However it was interesting to the researcher that no learner in the class had any recollection of such an experiment being done.

Ms Sassy's good subject matter knowledge was further displayed in her use of analogies during her lesson. Ms Sassy confidently told her learners:

> *The atom is like a hot cross bun, if you cut up the hot cross bun do you find all the raisins at the bottom?*

Her choice of analogies helped to facilitate learning by allowing learners to visualize the abstract domain of the atom and the notion of the sub-atomic particles being scattered all over the place (Duit, 1991) thus facilitating classroom practice that allowed for meaningful learning.

> *They are all over the place, so just like that the atom was a solid sphere but with positive and negative charges all around the place and we call this the current bun model.*
>
> *But why won't we accept this model? Because electrons are on the outside and protons in the center of the atom. So what is still missing in the atoms?*

The teacher's extensive content knowledge, gave her the confidence to construct learning activities that allowed for her to use a variety of teaching styles interchangeably in her lesson. After groups had completed their presentation, the teacher elaborated on their findings, she adopted various styles in her discussions. She used the traditional approach which involved her lecturing to her learners,

> *Before this discovery Faraday discovered there were charges, but he didn't know they were positive and negative as such he just discovered the electrical nature of matter.*

Although she made use of the lecturing approach to elaborate on explanations she gave to her learners, she simultaneously posed questions to her learners, which drew on their prior knowledge. She made use of a range of teaching styles which enhanced deep and active learning (Grasha, 2002). Thus the teacher was able to move between teaching styles during her teaching of the section on Matter and Materials and hence promoting a variety of learning styles, which empowered learners and made them participate in the class discussion (Ironside, 2003). This further helped to promote the development of decision-making in learners, which was observed when the teacher posed the question,

> *The Billard ball model, is just a solid sphere, would you accept something like that from us today?*

My Sassy's actions in the classroom demonstrated that as the teacher she was aware of exactly what content had to be taught and the depth of how far she had to go with abstract concepts. Ms Sassy's years of experience teaching Physical Science had developed her content knowledge as well as her general pedagogical knowledge. It was this general pedagogical knowledge that created a supporting framework for the development of her PCK (van Driel et al. 1998). Hence as the teacher she was able to provide her learners with opportunity that encouraged them to think rather than merely transmit information (Chin, 2006) constantly to them.

Contextual Knowledge

Context knowledge is the teachers understanding of the classroom in which he/she practices his/her teaching skills. It includes all the contextual aspects that could influence the teaching of the subject matter such as resources, socio-economic background and the curriculum (Mudau, 2016). Ms Sassy had conducted all her lessons in the laboratory. It was observed that the laboratory had an overhead projector, which was installed and operational according to Ms Sassy. To ensure that the classroom environment was conducive to learning, the teacher ensured that the subject being taught was reflected in posters and models. Thus Saiduddin (2003), states that every learner can be educated because it is the manner in which the learning environment is managed that determines the quality of education for its learners.

Ms Sassy had a total of forty two learners in her grade 10 Physical Science class. She revealed:

> *There are forty two learners in the class, it is difficult to see to every learners needs; when I had smaller classes like thirty is was easier you pay more attention to the learners.*

Although the teacher did not object to such a large class size, it did impact on her classroom practice as she was unable to attend to the concerns and needs of every learner. In Ms Sassy's questionnaire response she alluded to the d*isruptive behaviour (of the learners) when she said:*

> *It is hard at times to teach them learners... (Pause) ....They are disruptive.*

This is an obvious factor that hindered her performance in her teaching. At times, the learners would not pay attention to the presentation of the fellow learners neither did they give the teacher their attention when she elaborated on the findings.

During the field observations the researcher observed that on several occasions' learners who were seated at the back of the laboratory did not pay attention in class. Instead these learners were either copying homework for other subjects or engaging in their own personal discussions. Such behaviour was certainly noticed by Ms Sassy, hence she reprimanded the learners on several occasions for their behaviour,

If you (learners) don't like the rules in the class go to the other class.

To overcome the issue of poor discipline in her classroom, the teacher explained that she would try to win her learners over, by motivating them. Lumpe et al. (2000), states that to motivate teachers so that they become more effective in the classroom, they (the teachers) must engage in constructive interactive teacher programmes that is relevant to their context. Therefore in the case of Ms Sassy to motivate her learners, and gain their undivided attention in the classroom, her classroom practices should have ideally created opportunity for active learner participation on a frequent basis. Looi et al. (2016), states that learning Physical Science cannot be confined to the classroom, teachers must encourage learners to think outside the classroom and relate concepts to daily life.

It was observed that in all observed lessons Ms Sassy always began her lesson with a preliminary lecture, followed by the use of various learning approaches during her lessons. Ms Sassy's indicated that the learners in her class were from,

Out of school areas; all races.

Because Ms Sassy had a multi-racial grade 10 class it stands to reason that the social backgrounds of her learners differed. The Language of Teaching and Learning (LoTL) at Ms Sassy's school, was English, and for some learners English was a second language. Therefore her lessons encouraged learners to engage with each other and build on each other skills and knowledge through cooperative learning. Ms Sassy was in essence developing in her learners what Mchunu (2012), described as fundamental science thinking skills, such as creative and critical thinking, decision making and designing, and problem solving that is shared amongst learners from different societies.

The teacher alluded to the use of a variety of resources for the delivery of her lessons,

In terms of teacher aids we get power points that we use and we do have equipment for experiments but we would prefer to have more availability of new equipment.

However during the time the researcher had spent in the field, the only resources that Ms Sassy made use of where worksheets, whiteboard and learner texts. The teacher made reference to the use of power point presentations, because she felt that it would save her time.

> *Time is not a luxury we have, the grade 10 syllabus is very long and when it comes to doing the bigger topics it's difficult to get them to understand and work the way we actually want them to.*
>
> *We need a lot of time to practice the bigger topics like mechanics.*

According to the ATP (Appendix 13), grade 10 mechanics is a section that is only scheduled to be taught towards the latter part of term 3, and it's level of difficulty progresses through grade eleven and finally in grade twelve. The extensive grade 10 syllabus created a tremendous amount of pressure on the teacher. She felt that a great amount of time needed to be dedicated to what is deemed "bigger topics" like Mechanics. The foundation and basic principles and concepts of Mechanics is taught in grade 10 and is carried over to grade eleven and grade twelve. According to the National Senior Certificate Diagnostic Report for the National Senior Certificate Examination for 2014, 2015, and 2016 the sections of mechanics is till date very poorly answered by learners.

Although Ms Sassy indicated that she did have the availability of equipment to conduct investigations and experiments, she preferred new modernized equipment. However the frequency at which this equipment is used did become questionable. With regards to how often the teacher conducted experiments with her learners and the availability of the required resources for conducting experiments; the teacher's responses were as follows:

> *"When the topic allows us to do an experiment and if we have the equipment (under these conditions will the teacher do an experiment)."*
>
> *"If we have sufficient equipment, then learners work in groups and do experiments, if there is limited equipment then I do a demonstration."*
>
> *"No not all the resources (for conducting practical lessons are available), sometimes we get it (videos of the practical) downloaded from the internet and we play it to them and then we discuss it to them (learners), and that brings it more into light with them instead of not doing it all."*

The teacher's response (a) suggested that only when the above two conditions are met did she conduct experiments. Goodrum et al. (2001) states that limited resources does place a constraint on teaching and learning. For the duration that the researcher, spent observing the teacher, the only investigation that was conducted was the mixing of the heterogeneous substances and this did not require the use of specialized equipment yet the teacher did this as a demonstration. Although Naidoo and Lewin (1998), concur with Goodrum et al. (2001), they advise that effective use of available resources by the teacher also impacts on learner performance.

Teacher Knowledge of Learner Understanding

The teacher's understanding of her learners and their needs towards learning are important as it determines the how the teacher will structure his/her lesson. It is this knowledge that is also influential on the teaching style that the teacher adopts in the classroom. The teacher must have a pre-knowledge of her learners' abilities and their prior-knowledge, their misconceptions on the topic and sections that they perceive as being difficult (Magnusson et al., 1999).

According to the data from questionnaire and interview responses Ms Sassy posits that her learners were not at the cognitive development level that a grade 10 learner should be at.

> *Learners still use the simple terms they don't answer in the proper scientific manner, and it takes us time to get into that habit of answering in that manner. There are specific rules and laws that have to be applied and they can't do it, which is unacceptable. They give you off the cuff answers.*

Ms Sassy's was aware that to develop scientific literacy skills in her learners was going to take some time. This was evident from lesson observations, during which her years of experience as a teacher equipped her with the ability to rephrase questions to her learners using simplistic terms thus making it more understandable to her (as explained under teacher content knowledge). Her response indicated to the researcher that she as the teacher was aware of the learners' inability to answer questions using correct scientific terminology for example learners referred to the mass number of the atom as the bigger number; learners stated the center of the atom had the protons and neutrons rather than stating the nucleus of the atom has the nucleons. Ms Sassy alluded to the learners poorly developed prior-knowledge of Science as a contributory factor for learner's poor use of scientific terminology. The poor developed prior knowledge of the learners was influential on the teachers approach to teaching she adopted in her classroom.

According to Ms Sassy the focus of term one and part of term two was to develop her learners to answer questions using proper scientific terminology and explanations. Because Ms Sassy felt her learner's cognitive abilities were low she would repeat herself when teaching. She stated:

> *The learners are not mature enough for grade 10 Physical Sciences especially in term one and two. Answer in everyday language instead of scientific terms.*

The teacher emphasized through repetition the use of correct scientific terminology such as nucleons, atomic number, and atomic mass. Although she made use of worksheets, Ms Sassy put up summaries and annotated diagrams on the board; she insisted that her learners took it down in their books (appendix 16). The teacher felt that if she repeated and the learners wrote down the notes they would remember it. Consequently aiding them in the application.

When it came to teaching a new concept depending on the familiarity of the concept to the learners Ms Sassy varied her teaching style. The concept of the atom is first introduced to learners in grade eight Natural Sciences, therefore when introducing the section of the atomic structure and its history Ms Sassy used the question and answer approach (as given in the transcript). However again she wanted her learners to familiarize themselves with the correct scientific terminology, hence she moved between the lecturing approach and the collaborative approach to teaching, indicating that Ms Sassy's years of experience enabled her to modify her classroom instructional strategies based on her understanding of her learners. Mudau (2013), states that teacher knowledge influences all actions of a teacher in the classroom; Ms Sassy's knowledge of her learners' prior knowledge (i.e. their understanding of what they had learnt in Natural Sciences from previous grades) informed the type of instructional strategies she used in the classroom.

Ms Sassy's knowledge of her learners' conceptual understanding of the subject Physical Science when they entered grade 10 was,

> *When learners come to grade 10 they feel that Physical Sciences content is very similar to the Natural Sciences, which is not a high-keyed pathway.*
>
> *When the teacher posed the question below,*
>
> *What do we find in the nucleus of the atom?*

The all learners responded,

Protons and neutrons.

However at the grade ten level learners should have responded by saying nucleons, since nucleons is a scientific term that describes the contents of the nucleus of an atom. Therefore the prior-knowledge of the learners was not very good they were unable to make use of the correct scientific terminology.

According to the teacher her learners did have prior knowledge of Natural Sciences, which they were able to recall during her question and answer lessons. However she found that her learners viewed Physical Sciences as being similar to Natural-Sciences[1011] (Natural Sciences is taught in grades seven, eight and nine and provides a baseline understanding to the atom; while Physical Sciences provides greater details on the macroscopic and microscopic structure and nature of the atom.)

Hence she described the cognitive developmental level of her learners as being low. To address the issue of poor learner cognition Ms Sassy alluded to the use of the following intervention strategies when explaining concepts,

> *Simple language; go over concepts many times; do examples on the board, followed by a written summary on the board and then drawings.*

However, the teacher’s strategy of addressing poor learner cognition involved her using the traditional approach to teaching.

Ms Sassy alluded to learner apathy of learners as a hindrance to her teaching and as a result impacted on the delivery of her lessons. When the teacher was questioned if all learners in her class completed homework, the response received was as follows,

> *No, only the dedicated learners do all their work at all times.*

The laziness of learners further impacted on the teachers classroom practices,

> *If learners are enthusiastic and respectful I go the extra mile and make sure the learners understand the lesson, I will find alternative ways of trying to put the subject matter across to them.*

[11]Natural Sciences is taught in the GET phase and is composed of the following strands, Life and Living, Matter and Material; Planet Earth and Beyond; and Energy and Change. It is taught with the intent of learners linking each strand to the other and understanding the nature of the connectedness with each other (Department of Education, 2011).

Ms Sassy suggested that the apathy of learners impacted on the manner in which she had presented her lessons. When her learners gave her their undivided attention in class and actively participated in the lessons by answering questions that she had posed to them and displaying good behaviour it made Ms Sassy want to help them further.

Although Ms Sassy's subject matter knowledge was excellent in this section of work and she was able to relate it to the everyday lives of learners and make use of analogies; some learners just could not comprehend that which she was saying. For example when Ms Sassy explained the concept of energy that is transferred from one particle to another in water waves hence we see ripples when a stone is thrown into a pond. There were some learners in the class who could not understand the teacher's explanation, thus for those that did not understand Ms Sassy's explanation she made use of video simulations to assist them. The researcher observed that learners made short notes in their worksheets while watching the animated video clip of a stone thrown into water and the motion of the ripples. The learners had started asking questions (after watching the video clip) regarding the speed as they were able to then answer the questions on the worksheet, thus indicating an improvement in their understanding of the concept. The researcher observed that when learners gave the teacher their full attention it motivated the teacher to use alternative teaching practices in the classroom

Ms Sassy was of the view that her learners did not have an inquisitive mind, she stated in her questionnaire that,

> *Scientific inquiry not used all the time, but most of kids are not in that inquisitive idea way of things, they just listen to watch you saying.*

Ms Sassy also acknowledged of the difficulties her grade 10 learners experienced when it came to learning Physical Sciences,

> *It is a bit difficult in the beginning, they find the changing of the subject of the formula difficult. Also the English is a bit difficult, they have to read to understand so it takes us a bit of time to groom them.*

The learners in Ms Sassy's classroom had various factors that hindered their learning of Physical Sciences. They experienced difficulty in mathematics which impacted on their learning and their performance in Physical Sciences. As stated in the NSC Diagnostic Report (2016, 2015, 2014), for grade 10 Physical Sciences, learners were unable to use a scientific calculator and unable to convert to the correct units and solve equations; learners were unable to understand BODMAS calculations. This indicated that the learners' prior mathematical knowledge was very poor. Ms Sassy had to assist her learners with the mathematics aspect that was involved with teaching Physical Sciences. Further to this their comprehension and language skills created hindrances in their learning, hence she used a lot of explanatory frameworks in her lessons with the expectation of that it would help learners comprehend the targeted concepts (Childs and McNicholl, 2007). Therefore the teacher's classroom practices was highly dependent on her learners. In order to have meaningful learning take place, the teacher must have an understanding of his/her learners before teaching (Leinhardt and Greeno, 1986).

Teacher Beliefs

According to Ms Sassy during her very first years of teaching (which was over thirty years ago), she was mentored and much of what she knows today and practices is attributed to her mentor. According to Ms Sassy the practical knowledge she has gained over the years in the classroom is what helps to develop the theories that drive the decisions she makes in the post-apartheid classroom (Lotter et al, 2007). Hence to change the beliefs of an experienced teacher as Ms Sassy would be far more difficult than to change the beliefs of a pre-service teacher (Lortie, 1975 and Tschannen-Moran, Woolfolk Hoy, and Hoy, 1998).

Based on Ms Sassy's response to the questionnaires her beliefs on the founding principles for teaching and learning Physical Sciences at grade 10 include the use of,

> *Inquiry, experimentation and research.*

Ms Sassy's beliefs were triangulated with her actions during her of teaching and learning Science. During lesson observations of Ms Sassy, she paired learners into groups and assigned them the task of researching the discoveries made by various scientists on the atom. The learners then had to present their findings to the class.

Ms Sassy, was of the belief that learners needed to be responsible for their learning, hence she had encouraged group work and research, and thus her beliefs fostered the delegator teaching style in her. In Ms Sassy's questionnaire response she had indicated that her learners only matured towards the latter part of the year,

> *Not mature enough for grade ten Physical Sciences…they mature later in the year.*

These sentiments were further reiterated by Ms Sassy during interviews. However because she was so set in her beliefs of learners needing to take responsibility for their learning she failed to take into account the maturity and cognitive development of her learners. The teacher delegated them with a task (researching the discovery made by particular scientists) that proved to be more fact based learning and acceptance rather than critical engagement with the content which resembled that of the apartheid education (Seroto, 2004).

This was observed when Ms Sassy made use of the idiom (during lesson observation),

> *You all missed the boat.*

The teacher implied that the learners had failed to understand the objective of the whole exercise. Chilembe and Bruce (2015) state that when the teacher adopts the delegator style of teaching in his/her classroom practice although the aim is to develop autonomous learners, it is essential the maturity of the learners are taken into account. According to the ATP (appendix 10) that Ms Sassy followed (which was a duplicate of that followed by the teacher in case 1), the atom and its structure was to be completed in term one by the last week of January 2017. Ms Sassy was knowledgeable of her grade 10 learners' late maturity yet she did not tailor this factor in her classroom practice because her beliefs. Richardson (1996), stated that the beliefs of teachers influenced their thought processes which in turn affected their classroom practice.

According to Ms Sassy inquiry teaching involved:

> *"I think would be more asking the children to do the research and go and inquire about things and then come in and we put it together into the right context."*

Her understanding of the inquiry approach to teaching was in line with what Harris and Rooks (2010), describe the inquiry approach as creating opportunity for learners to be actively involved in scientific practices, such as designing and conducting experiments and investigations. Ms Sassy was of the opinion that the inquiry approach to teaching could not always be used in a South African classroom because:

> *"Lots of them (the learners) don't get to do the research because maybe they don't have the stuff at home or they are just too lazy."*
>
> *"Eagerness of the child, not that eager about getting the work done using the inquiry manner, they prefer us to just give them everything. Across the grades learners expect to be spoon fed."*

Ms Sassy felt that the socio-economic status (statement *I*) of a learner had impacted on his/her learning; because she felt that not all learners may access to technology in their homes, yet during the lesson observation she did not tailor classroom instruction using the inquiry approach. However given the teacher's understanding of the term "inquiry learning" her actions (asking learners to go and do research) of the observed lesson (researching the discoveries made by individual scientists on the atom) refuted her beliefs on the socio-economic status of learners.

The teacher further felt that learner apathy (statement *II*) was a major influence on her classroom practice. From the observations of the teacher in practice, her role in the classroom was that of a facilitator, and she wanted her learners to take responsibility for their learning. The teacher adopted the constructivist approaches to teaching her classroom, she was of the firm belief that Physical Science could not be taught like History, which she referred to as,

> *"Story telling subjects".*

Ms Sassy's statement, indicated that she did not believe in teaching Physical Sciences through the traditional methods only – which perceived teaching science as transferring knowledge from teacher to learners (Lumpe et al., 2000) hence there was no room for the learners' to display laziness because they had to be actively involved in the learning process (Imende, 2005). Her beliefs contradicted her actions as she used the expert style of teaching as part of her classroom practices.

Ms Sassy described the daily structuring of her Physical Science lessons for all grades as follows:

> *"Start by marking homework, then a recap on the previous day's lesson, if there is a new concept to be introduced, I explain and draw notes on the board to make it clear. Repeat it two or three times. Then the learners will take down the notes. Then I continue to build on the topic."*

During lesson observations, when Ms Sassy introduced content to the learners she incorporated a lecturing approach, she would then simultaneously present to the learners questions related to the topic and then identify with their prior knowledge. The prior knowledge of learners creates the foundation for new learning, and learners will learn by progressing through increasing complex concepts and skills (Milner, Templin, and Czerniak, 2011). The teacher also applied a constructivist teaching approach to her pedagogy and allowed for the scaffolding learners' learning; Fosnot (1996) and Gibbons (2002), affirm that learning is a social process as it is the result of an individual's historical, social and cultural experiences according to Lev Vygotsky Sociocultural Theory.

For learners who had difficulty in comprehending that which the teacher was saying she made annotated diagram of the atom on the board (Appendix 16). Ms Sassy felt that to be a teacher of Physical Sciences, she had to be dedicated. She believed that,

> *"Disruptive behaviour of learners and disinterested learners."*

Were factors that hindered her as a teacher. However she addressed such obstacles with a very positive approach. To try and rectify the situation the teacher would,

> *"Guide them … motivate learners. I am there to get content across to my learners. No matter what the situation is I continue with my work."*

For Ms Sassy her priority was curriculum implementation and delivery. No matter how disruptive her learners got, she reprimanded the students in question, and has set clear rules for them to follow which she had reminded the learners of on several occasions in her lessons and she would then continue with her business of teaching and learning. This concurs with Lump et al. (2009), research that when the context beliefs of teachers are positive then they will function effectively in the classroom.

Her beliefs in terms of her dedication as a teacher of Physical Sciences were echoed in her openness towards engaging in more professional development workshops (discussed in detail further on in this chapter) for grade 10 Physical Sciences. Through her years of experience the teacher had a greater content knowledge of Physical Sciences,

> *"Yes, I have been teaching for many years (the teacher felt that she was well trained in the content)"*

and therefore displayed a greater degree of confidence and motivation towards attending professional development workshops (Steyn, 2009).

Professional Development

Ms Sassy believed professional development was about the,

> *"Development of educators to perform better in class."*

In her questionnaire she explained professional development as,

> *"Attending workshops that make us aware of better and easier approaches to teaching the topics, and make us aware of what the current field is looking at."*

Ms Sassy's responses indicated that she had a good conceptual understanding of the term professional development.

Ms Sassy had over three decades of experience as a teacher,

> *"39 years in 2 schools in Durban Central, grades 10, 11, 12"*

Teaching Physical Sciences, she was still open to the notion of professional development. This concurs with Steyn (2009), whom stated that teachers who had a greater content knowledge of their subject displayed a greater degree of confidence and motivation towards professional development in terms of developing their knowledge and skills.

Ms Sassy had indicated that she was not the only grade 10 Physical Science teacher as her school. At the start of the academic year of 2016, a newly qualified teacher had joined their school and was allocated Natural Sciences and one grade 10 Physical Sciences class. It should be noted that the novice teacher declined to be a part of this research. Jita and Ndlalane (2009), state that some teachers have a fear of confronting their inadequacies in their content knowledge and their pedagogical content knowledge.

Ms Sassy alluded to professional development that would help improve her methods of approaching a topic and introducing the content to the learners, i.e. her PCK would be improved. Therefore professional development should be used as a mechanism for deepening teachers' content knowledge and developing their teaching practices (Desimone et al., 2002). The teacher was also of the opinion that for professional development to be beneficial to teachers, it should be planned based on the following,

> *"Look at topics learners performed poorly in NSC exam; explain the content for that topic, common errors and how to bring this to learners' attention. Explain a few calculations on that topic."*

This information is gained from the Diagnostic Reports and should be used as a guideline for grade 10 as grade 10 creates the foundation for grade eleven and ultimately grade twelve. The teacher's responses and views toward professional development concurred with the works of Avalos (2011), who stated that professional development for teachers is about teachers becoming learners, learning how to learn and finally cascading this knowledge to learners in their classrooms through classroom practice.

Ms Sassy's highest academic qualification included a Masters in Science Education, therefore she had a broad subject matter knowledge. However, she felt that there was still room for improvement in terms of her classroom practice. She indicated that she did engage in professional development, however none of the programmes focused on the grade 10 Physical Science content.

> *Emphasis is on grade twelve work*

All workshops that were planned by the district focused on grade twelve Physical Sciences, and the last grade 10 workshop she attended was when CAPS was first introduced to grade ten; and such signal approaches to professional development does not yield positive results (Dass, 1999). It is grade 10 that lays the foundation for Physical Sciences therefore it is essential that teachers teaching grade ten are proficient in their subject matter knowledge as well as methodological approaches to teaching Physical Sciences (Anthony and Walshaw 2009; Drake, Spillane, and Hufferd-Ackles, 2001; Jita and Ndlalane, 2009; Zakaria and Daud 2009).

When the researcher questioned Ms Sassy on her ability to conduct experiments, and practical skills the response the researcher received was a bit alarming because she had been teaching Physical Sciences for so many years. Ms Sassy felt that practical workshops i.e. workshops that actually involved the teachers physically conducting experiments would in fact enhance her teaching,

> *"Yes, yes it would really."*

She then went on further to say,

> *"I may be doing the practical and it maybe not a hundred percent correct or I could be doing it incorrectly."*

> *"It would definitely help to have a practicals workshop that will explain the practical and how to conduct it, provide the teachers with guidelines on how to do the practicals and the CASS pieces and how to prepare learners for the exams."*

It was the above response in particular that alarmed the researcher. When Ms Sassy was questioned on the frequency of conducting experiments in class, she alluded to the availability resources as a determinant. However, the teacher's comment "*practicals workshop that will explain the practical and how to conduct it"* suggests that although Ms Sassy was competent in terms of theoretical aspects, her ability to execute it practically was a problem. Geyer (2008), stated that teachers learn best through experiences in various social contexts, and they are receptors and creators of the knowledge base they apply in numerous decisions in the classroom.

Having no professional development workshops that focused on the development of practical skills in teachers created room of uncertainty in Ms Sassy. Ramnarain (2013), states that professional development programmes must be tailored according to the needs of teachers, and from Ms Sassy's response, the development of practical skills in teachers irrespective of years of experience is essential. The National Strategy for Mathematics, Science and Technology (DoE, 2001), indicated that higher education institutions needed to develop Rigorous, high quality and relevant training programmes for teachers that will assist in strengthening both subject matter expertise and pedagogical content knowledge.

Ms Sassy envisaged professional development that equipped teachers with the knowledge and approaches to answering higher order questions; explanatory and practical workshops for prescribed experiments; workshops that developed teachers' content and varying approaches to delivering the content. Badasie (2014), states that to achieve such outcomes collaboration is required amongst colleagues therefore professional development is conceived as a socially negotiated activity.

During the teacher interview sessions Ms Sassy made the following comment regarding professional development for grade 10 Physical Sciences,

> *"Teachers are expected to set the tone in grades ten and eleven, and only in grade twelve they would call us in to up our game."*

The above statement indicates that the attention given to grade ten Physical Sciences (by the District) which creates the foundation of Physical Sciences in the FET phase does not exist and therefore is a cause for concern.

5.3.3. Findings

The outcomes of this study are to understand how the experiences of the teacher have influenced her classroom practices.

TEACHER KNOWLEDGE

Being a teacher of Physical Sciences for over three decades, Ms Sassy was proficient in the theoretical aspects of the subject matter knowledge and its organization. She was able to incorporate topics that learnt itself to the section she was teaching so that it aided her in her explanations to the learners. The explanatory frameworks used by Ms Sassy during her lessons incorporated a range of analogies and examples that learners could relate to. This demonstrated the teacher's excellent content knowledge and conceptual understanding of topics being taught. Her ability to deliver a theoretical lesson without the use of a textbook also demonstrated high levels of confidence in herself during classroom practice.

Because the teacher had so many years of teaching experience her PCK was well developed. Therefore for sections that were very theoretical (such as the history of the atom), to avoid exclusively the use of the theoretical view of teaching (which involved the transfer of knowledge from teachers to learners) the teacher paired her students into groups.

The teacher was certainly innovative in her choice of resource material, because for many learners in her class the LoTL was a second language. She made use of teaching aids such as power point presentations to help improve learner understanding. However during these presentations the teacher's lesson presentation followed the same pattern as described in Figure 9. Ms Sassy was aware of the basic skills and concepts she wanted her learners to achieve at the end of grade 10, unfortunately her classroom practices were not developing these skills and concepts in learners.

BELIEFS

Two teaching styles dominated Ms Sassy's classroom practice, i.e. the expert teaching style characterized by her constant practice of lecturing lessons and the delegator teaching style which reaffirmed her beliefs of Physical Science learners as being self-disciplined and motivated. Her constant use of the two styles resulted in monotonous lessons and as a result learner behaviour and interest in the lesson was lost Ms Sassy was believed that the cognitive developmental levels of her learners were low. However she failed to structure her lessons in a manner that actively a involved the learners. From observations of the teacher in practice the researcher infers that the classroom practice was greatly influenced by her belief, it followed common pattern as illustrated in Figure 9 below.

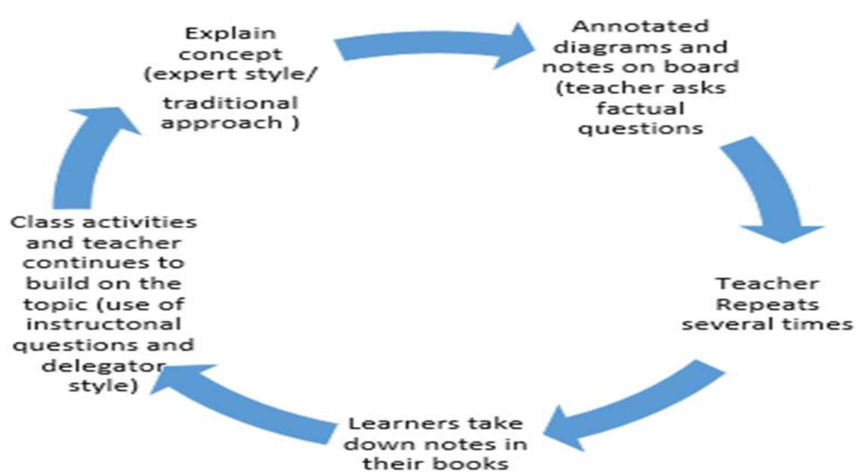


Figure 9: Cyclical Nature of Ms Sassy's Classroom Practice

Ms Sassy acknowledged that her learners' cognitive abilities were not at the levels it should have been at for their age and as a result they perceived Physical Sciences as being equivalent to Natural Sciences. Therefore majority of her lessons began with a very traditional approach to teaching during which she adopted the expert style (as shown in figure 9). The teacher believed that by adopting such a style of teaching together with the use of annotated diagrams (where applicable) and summary notes and then repeating her explanation several times she would be able to get the learners into the routine of using proper scientific terminology in answering questions. The teacher's repetition indicated that she unconsciously was engaging in rote learning, and ultimately created a dis-interest in her learners. During class activities the teacher adopted the delegator teaching style to develop autonomous learners. The impact of Ms Sassy's classroom practice on her learners was that the learner's conceptual understanding of Physical Sciences and scientific skills which she wanted to her learners to achieve was in fact not being developed in them.

PROFESSIONAL DEVELOPMENT

Since the inception of CAPS, there has been only one grade 10 professional development workshop that was content based and had not focused on physically conducting experiments. Thus professional development for grade 10 Physical Sciences is virtually non-existent in the selected district in KZN. Grade 10 creates the foundation of conceptual understanding for topics covered in grade twelve. Although Ms Sassy was well versed in the grade 10 theoretical content, her knowledge on conducting practical work/ experiments was weak. When it came to the prescribed experiments the teacher showed her learners a video of it and then explained that which was happening. By adopting such practice the teacher eliminated group work and the scaffolding of learners' knowledge through a social plane. Consequently Ms Sassy lecturing of practical experiments to her learners would have eliminated from their learning important basic scientific skills such as being able to account for experimental errors. Thus professional development for experienced teachers like Ms Sassy needs to focus on inquiry forms of teaching (i.e. conducting experiments); and the development of classroom practices that promotes and develops higher cognition in learners. Therefore the researcher infers that irrespective of the years of experience that the teacher has in the classroom, professional development for all teachers in a South African classroom is essentially.

It is worth noting that a novice teacher had just joined Ms Sassy's school as a grade 10 Physical Science teacher. The novice has had no prior experience of teaching Physical Sciences and neither did she attend any professional development workshops for grade 10 Physical Sciences because there are none. Ms Sassy was appointed as the mentor teacher; mentor teachers are allocated to novice teachers to provide them with support (Meyer, 2002). When the mentor has uncertainty about her own accuracy in conducting experiments and investigations, then the chance of incorrect information and skills being passed on becomes greater and it is indeed the experiences of a teacher that shapes their classroom practices.

5.4. CASE 3: MR HILL

5.4.1 DATA PRESENTATION

Table 5a: Key of symbols and terms for analysis of data - Case 3 Mr Hill

Symbols/Terms	Explanation
SMK	Subject Matter Knowledge includes knowledge of the grade ten syllabus and understanding of the requirements of the subject as stipulated in the CAPS document for Physical Sciences.
LPK	Learner Prior Knowledge
TVT	Traditional View of Teaching
TA –L	The teacher teaches using the tradition method of teaching i.e. teaching is unidirectional and the teacher is the main source of information.
CVT	Constructivist View of Teaching
CVL	Constructivist View of Learning
Discipline	The manner in which the learners behave in class.
LA	Learners Apathy
Difficulty	The problems the teacher experiences with teaching in the classroom due to various factors.
LC	Learner Cognition
Extensive Syllabus	The grade ten Physical Sciences curriculum covers too many topics and as a result delivery of the curriculum becomes a problem due to time constraints.
KMT	Kinetic Molecular Theory

Teacher Knowledge

The section below presents data collected from Mr Hill.

Table 5b captures the characteristics that exemplified the knowledge of Mr Hill. The focus was on the knowledge of his content, context and understanding of students' learning.

Key: R – Researcher MH: Mr Hill L: Learner R*: Researcher note

Table 5b: Teacher knowledge - Case 3 Mr Hill

Theme	Category	Characteristics
Teacher Knowledge	**Content Knowledge**	**R:** *The transcription includes the aspects relevant to the theme. **R:** *Mr Hill was following the ATP (appendix 10) and during the time that he was observed, he was on the section of Matter and Materials. The transcription below is from a lesson on the Kinetic Molecular Theory. **MH:** learners in grade nine you learnt of the three phases of matter. What are they? (Learner prior knowledge) **L:** Solid, Gas and Liquid **MH:** Can some describe the states of matter? **L:** Gas is when atoms have large spaces between them, liquid has smaller spaces between then and solid has no spaces between them. (vague/basic response by learners) **MH:** what do you mean when you say between them? **L:** The particles that make up the matter have spaces between them. **MH:** Good, please answer using correct terminology because at grade ten you will be marked down for vague answers. (teacher aware of the common mistakes learners make) **MH:** Think of water that coming out of the tap it is in the liquid phase. You agree? **L:** Yes **MH:** when you have ice forming in the freezer, what state is water in there? **L:** solid **MH:** ok good and very often you hear people say Durban has a high humidity level indicating that there is a lot of water vapor in the air, so that is water in which state? (good SMK)

		L: Gas **MH**: Good, now we need to know how or what causes water to change into these different states, that is what kinetic molecular theory explains to us (teacher writes KMT on the board) **MH:** In summer Durban has heavy rainfall, geography students you should know this and the next day it the sun is out and it is extremely how. What happens to puddles of water? (teacher relates content to common occurrences) **L:** The water would have dried up. **MH:** Dried up? **L:** It evaporates. **MH:** And what physical state would that now be? **L:** Gaseous state. **MH:** What caused this water to evaporate? **L:** The heat from the sun. **MH:** Yes it was the heat from the sun, in other words the temperature (teacher writes the word on the board) cause the water to go from a liquid phase to a gas phase. **R:** *The teacher use a question and answer approach to start his lesson. Learners gave the teacher their attention and participated in the class discussion. **MH:** But how? The KMT tells us that water when is a liquid the molecules have forces of attraction between them, when there is an increase in temperature, these forces weaken and the molecules can break away. When they break away that is when there is a change in phase of liquid to gas (TVT, good SMK, and teacher made use of diagrams on the board to help aid his explanation to the learners (Appendix 17). **MH:** The similar situation occurs with water in the solid state, because the molecules are so tightly packed in an arrangement called a crystal lattice, the forces that

		hold these molecules together are very strong. By adding heat to it what are we doing? (SMK) **L:** Breaking the forces. **MH:** Yes we are causing an increase in the temperature and breaking the forces that are holding onto the molecules. **MH:** Are we all clear? **L:** Yes **MH:** Do you agree that the molecules start to move when they change phase? So if they are moving we say that the molecules have gained kinetic energy. **MH:** Turn to KMT in the text let us read. (The teacher requests a learner to read aloud from the text). **R:** *After the teacher had given a prelude and explanation to the section he concluded the lesson by getting learners to read the notes in the text aloud to the class and then got them to complete an activity from the text. (TVL)
	Contextual Knowledge	**R:** *The transcription includes the aspects relevant to the theme, from the teacher responses to questionnaires, interviews and observed lessons. **R:** How would you describe the socio-economic status of learners at your school? (particularly those that do Physical Sciences) **MH:** Most are living under sub-economic conditions. **R:** As a teacher do you feel that you are equipped in terms of teaching aids to deliver the curriculum for grade ten Physical Sciences? **MH:** Yes **R:** Do you have a laboratory in which you teach? **MH:** Yes **R:** Are practical lessons conducted on a frequent basis?

		MH: No not frequently because there are time constraints. The Physical Science syllabus is vast, and a lot of time has to be spent teaching and you have to find the time to do the practicals. This applies to grade ten eleven and twelve also. (Time management) **R:** Is reading before coming to class essential? **MH:** In Physical Sciences, I will say go do your homework so we can consolidate the work the next day. (Reading) **MH:** I still try to get that child up to speed in the class and it improves the other learners. (LSA, and impact on time management). **R:** Do you think if learners came into grade ten with the required pre-knowledge, would you then be able to sufficiently complete practicals? **MH:** Yes, we would be able to get through the learning material much faster, not spending too much teaching for understanding and there will be more time do practical's. (LPR) **R:** Can you describe instances that have hindered your teaching in anyway? **MH:** When a child is not paying attention, they have to listen to respond; discipline of learners; noisy learners. (discipline) **R:** Describe your teaching environment? **MH:** my teaching environment is not conducive to learning but I make it conducive by keeping the learners involved, constant interaction question and answers. I have 32 learners in my class. The class size is too large, I think 24 learners would be ideal, A small class facilitates practical work. Every practical Every prep lesson in the RSA classroom is discipline – it's the first thing you have to address. (Classroom layout, and issues of discipline) **R:** What frustrates you most about teaching?

		MH: Badly behaved learners **MH:** Discipline influences the way you teach. Eg. a child who is disruptive in class you do a total 360 as to how you go about teaching that lesson. And if the child is continuously disruptive you rather put the child outside the class and continue with the lesson with those that want to learn.
	Teacher Knowledge of Learners Understanding	**R:** *The transcription includes the aspects relevant to the theme, from the teacher responses to questionnaires, interviews and observed lessons. **R:** *The transcript below is an extract from an observed lesson of Mr Hill. He was teaching the calculations of the section on Electromagnetic Radiation **MH:** when calculating frequency two equations can be used. (The teacher wrote equations on the board, $v = f\lambda$ and $T = 1/f$). However with EMR, we substitute c in place of V and manipulate the equation with the energy $E = hf$. **MH:** Use the exponential form for these calculations on you calculator. Everyone take out your calculators. (Poor prior mathematical knowledge and skills of learners). **R:** *Mr Hill, begins to teach his students how to use the functions of the calculator and manipulate equations – all of which are mathematical skills. More than 25 minutes of his lesson was spent on doing this. **R:** What is your greatest challenge in terms of implementing the curriculum? **MH:** With regards to the type of learner that is coming to grade ten nowadays, you find that the mathematics hasn't been taught very well in the lower grades and for many learners it is a very big jump going from grade nine to grade ten. (LPR in mathematics is poor) **MH:** So many learners want to do Physical Sciences and they do not know what they are getting into and as a result as

		the end of the year many of them drop Physical Sciences and go into other subjects, because their Math skills are so poor (Difficulties, LCD). **R:** How do you structure your Physical Science lessons based on your learners and their ability? **MH:** First of all you have to take into consideration the topic you are teaching because different topics require different strategies. For example when teaching elements, teaching strategies can involve showing learners examples of elements and then using worksheets. For Waves, it is different. **R:** Do you think the cognitive levels of your learners are at the stage that they should be for grade ten? **MH:** NO, that why I say there is big jump, they are not ready. **R:** What skills do you want your learners to achieve at the end of grade ten? **MH:** They should have a fairly good understanding of the theory that is taught in grade ten, in preparation for what follows in grade eleven. Certain concepts taught in grade ten must be well understood before you can continue with the same concept in grade eleven and twelve. (LSA) **R:** Do your learners complete homework and classwork timeously? **MH:** Well you know there is no such thing as set home work. Physical Sciences has homework every day, because if classwork is not completed during the lesson then learners are asked to complete it as homework. **R:** Do all of you learners complete the homework then? **MH:** It is not actually homework, but a spill over of classwork. I tell the learners complete it at home and we will go through it in the next lesson No, I would say about fifty to sixty percent do the homework and the others loaf. And it's

		evident in their results at the end of the year. (LA) **MH:** Putting more time into the studies will benefit the learner. Often learners come to me and say I don't understand and I say go home read over it and come back tomorrow with questions on what you do not understand. Learners who do this and working on their own are performing far better than those who do not.

Teacher Beliefs

The table below represents the Beliefs of Mr Hill, in terms of his teaching of Physical Sciences and his grade 10 learners who are studying Physical Sciences. The table below indicates the responses of Mr Hill to the interviews (Appendix 7), questionnaire responses (Appendix 8) and classroom observations (Appendix 6).

Key: R – Researcher R * - Researcher note MH –Mr Hill L – Learner

Table 5c: Teacher Beliefs - Case 3 Mr Hill

Theme	Category	Characteristics
Beliefs	**Teaching & Learning of Physical Sciences**	
		R: *The transcription includes the aspects relevant to the theme, from the teacher responses to questionnaires, interviews and observed lessons. **R:** What in your opinion is the best way to teach Physical Sciences? **MH:** Good understanding of the topic being taught by the teacher and for the learner the main ingredient is hard work. The difficult questions they are presented with, the only way to get better with that is to practice and practice and practice. (continuous practice of examples allows for students to master the subject) **MH:** Give learners an example based on what you taught, they must go home and go over that. They must reach a point in their learning when they are present with any problem they must

		be able to come up with a solution, now that is learning. (focuses more on problem solving activities) **R:** What do you consider to be the founding principles of teaching Physical Sciences? **MH:** Discoveries and inventions. (active learning and experiments) **R:** What do you understand by Learning? **MH:** learning is when a child is able to do things on their own. (active learning) **R:** What has motivated you to become a teacher? **MH:** Teaching was a calling in 1972 for me, not a profession. As the years went by I learnt something new, which has improved my ability to teach. (intrinsic motivation) **R:** What do you understand by the term inquiry teaching? **MH:** Asking questions. (misconception) **R:** Do you use the inquiry method in your teaching? **MH:** Yes, I use the question and answer method. **R:** Do you believe this approach is appropriate for the South African Classroom? **MH:** Yes, it applies in all situations. **MH:** Self-discovery is the ideal way for teaching Physics. Science is all about testing theories. Trial and error. (conducting experiments and investigating phenomenon) **MH:** The vast syllabus does impact on practical activities. And there are deadlines, there are so many practical activities that can be shown to learners if some of the sections in

		the syllabus is removed. (time management is a major concern) **R:** Can physics be taught like subjects such as History? **MH:** No, there are important practicals that have to be done and shown to learners. **MH:** A good learner is diligent is committed and has a thirst for learning, fairly good background of Maths and English skills for understanding. (Dedicated to learning) MH: Maturity wise these kids cannot cope with the jump from grade nine to grade ten. It is a big jump.

Professional Development

The table below represents the Professional Development of Mr Hill, in terms teaching and his learners. The data indicated are the responses of Mr Hill to the interviews (Appendix 7), questionnaire responses (Appendix 8) and classroom observations (Appendix 5 and Appendix 6).

Key: R – Researcher MH –Mr Hill

Table 5d: Professional Development - Case 3 Mr Hill

Theme	**Category**	**Characteristics**
Professional Development	**Teacher Developmental workshops for grade 10**	
		R: *The transcription includes the aspects relevant to the theme, from the teacher responses to questionnaires, interviews and observed lessons. **R:** What do understand by professional development? **MH:** Behaviour, interaction with colleagues also is part of professional development. (Peer teaching) **MH:** A good teacher, is committed and dedicated, versed well in technological skills (comp, smartboard) has a desire for

		his/her learners to succeed, love and passion for teaching. **R:** How would you structure a professional development programme? **MH:** Look at the examiner's report and look at what the problems are and deal with the identified issues. Print material for teachers to improve their content knowledge. **R:** Do you have visits from your subject advisor? **MH:** No. But we got workshops once a term. The workshop focus is grade twelve. **MH:** Workshops happens three times a year, there is no workshop in term 4. It covers content, practical work, tests as well as design of these practicals. (TCTP) **R:** For a novice teacher, are the workshops adequate? **MH:** They are important because certain standards have been set and the teacher has to make those standards. Practice makes perfect. (TA) **R:** Do the workshops train you in terms of practicals? **MH:** No. The workshops do not physically do the practicals. Since 2007 there was only 1 occasion where practical work was actually done at a workshop. (No TPTP) **MH:** The disadvantage I find these days is some of the equipment for practical's is so advanced even I do not know how to use it, yet I am an experienced teacher. **MH:** What the department should do is, do practical lessons on a regular basis with their science teachers, teach them how to use the new equipment that becomes available. **R:** Do you feel that you need more professional development to improve your classroom practice?

		MH: I am coming to the end of my reign. However the young lady who is taking over from me attending workshops will improve her knowledge and make a difference to her capacity building. (TCTP and TPTP) **R:** Will Professional Development which includes theory as well as practical work, result in improved teacher performance? **MH:** Exactly. Both components are required. (TCTP and TPTC are essential)

5.4.2 Discussion

Content knowledge

Mr Hill had been teaching Physical Sciences for over four decades. It is interesting to note that his experience as a teacher ranged from classrooms of a private school and state school both nationally and internationally. Kagan (1992) states that as a teacher's experience in classrooms grows, the personal knowledge of the teacher grows richer and more articulate and consequently forms a highly personalized pedagogy or belief system which actually controls the teacher’s perception, judgment, and behaviour in the classroom. Mr Hill was very confident in his subject matter knowledge and this was observed when he delivered his lessons. He was able to deliver lessons without making any reference to a textbook. However he was still open to learning. Mr Hill said:

> *“I am still learning even today.”*

While observing Mr Hill deliver a lesson on The Periodic Table and its elements, Mr Hill used samples of elements that he had available in his laboratory such as Sulphur, which was a yellow powder. He further explained in his lesson,

> *“Elements can occur in various states, Sulphur is a solid, iodine is a liquid and oxygen is a gas.”*

Mr Hill demonstrated sufficient and organized subject matter knowledge for Physical Sciences. The organization of his subject matter was seen in how he introduced the topic and the sequencing thereafter (Kind, 2009). When Mr Hill taught the Kinetic Molecular Theory, to ensure the meaningfulness of the subject matter for his learners Mr Hill made reference to background knowledge in his teaching that learners could relate to.

> *“In summer Durban has heavy rainfall, geography students you should know this and*

> *the next day it the sun is out and it's extremely how. What happens to puddles of water?"*

The use of background knowledge when introducing new subject matter to learners is important as it helps to eliminate teaching difficulties and shapes learner understanding (Staver, 2007; Hausfather, 2001).

Observing Mr Hill on several occasions the researcher noted that he began his lesson by building on the prior knowledge of learners. His organized the content matter in a manner that allowed for the scaffolding learning. Mr Hill presented learners with very basic questions,

> *"Learners in grade nine you learnt of the three phases of matter. What are they?"*
>
> *"Can someone describe the states of matter?"*

Mr Hill then tactfully constructed his lesson around their responses. Lekgoathi (2010) states that learning under the principles of OBE is a two-way process, learners must actively engage in the learning process; they would have to recall their prior knowledge and build on it through the process of constructivism. Mr Hill's classroom practice of starting his lessons with the question and answer approach had forced his learners to pay attention and recall their prior knowledge. Mr Hill was very firm in his tone and he therefore came across as being very authoritative in his classroom.

Mr Hill's practices did not involve individualization due to constraints created by various contextual factors (discussed in detail under contextual knowledge), neither did it involve collaboration i.e. learning engaging in group work, thereby allowing for scaffolding. Wenglinsky (2002), suggests that irrespective of the knowledge that learners brought into a classroom, in order for the teacher to attain the result of meaningful learning, Mr Hill's classroom practice should have incorporated individualization, collaboration and authentic assessment. However the teacher's years of experience helped him to improvise. Thus allowing for learner participation through a question and answer approach (as given in the transcript below). From which he built his lesson on the learners' response. Thus Mr Hill used his questions to develop his lesson rather than to construct understanding (Chin, 2006).

> *"In summer Durban has heavy rainfall, geography students you should know this and the next day it the sun is out and it's extremely how. What happens to puddles of water?"*
>
> *"The water would have dried up. (Learner response)"*

“Dried up?”

“It evaporates. (Learner response)”

“And what physical state would that now be?”

“Gaseous state. (Learner response)”

“What caused this water to evaporate?”

“The heat from the sun. (Learner response)”

The teacher related the content he was teaching to the authentic activities and experiences of learners thus making the content it easier for learners to assimilate.

According to Mr Hill the question-answer approach that he had used to teach Physical Sciences was what he understood to be the inquiry approach to teaching, however the inquiry approach involves the active involvement of learners in scientific investigations (Gillies and Nichols, 2015). When Mr Hill delivered his lessons he always maintained position close to the board because he would draw spider diagrams (Appendix 17) on the board to enhance learner understanding.

When Mr Hill presented his lessons, his tone was very authoritative and his questions that he had poses to his learners did not facilitate class discussions. Once the teacher had established that the learners had a good prior knowledge (based on the responses to his questions) of the content being taught, the teacher moved into the traditional method of teaching and presented the grade 10 content to his learners by lecturing to them and he simultaneously aided his explanations with diagrams (Appendix 17). Mr Hill demonstrated an expert teaching style when it came to putting new content across to learners; he did not create opportunity to challenge his learners’ thoughts and when he asked a question he immediately answered it himself.

“Yes it was the heat from the sun, in other words the temperature cause the water to go from a liquid phase to a gas phase.”

“But how? The Kinetic Molecular Theory tells us that water when is a liquid the molecules have forces of attraction between them, when there is an increase in temperature, these forces weaken and the molecules can break away. When they break away that is when there is a change in phase of liquid to gas“

After Mr Hill had lectured to his learners the causes for the change in phase of water from a liquid to a gas, he immediately explained how a change in phase from a solid to a liquid occurs. Given the teacher's years of experience and subject matter knowledge, Mr Hill could have provided his learners with an activity that required them to account for the change in phase of ice to liquid water using his example as a guide. Thus the teacher would have alternated his teaching style between the expert and personal model as he would have directly observed the learners and guide them in answering the question (Chilembe and Bruce, 2015); as well as identified misconceptions that may have existed in their conceptual understanding of the content.

The theoretical aspects of Mr Hill lessons showed his subject matter knowledge of Physical Sciences was extensive. After Mr Hill had taught the section on Kinetic Molecular Theory (KMT) according to the ATP (appendix 10), learners were required to perform a prescribed practical as a formal assessment task, which was the heating and the cooling curve of water. The textbook that the learners used had outlined the procedure for this prescribed practical to be conducted (Appendix 18), however this prescribed practical was conducted as a demonstration and it was only the cooling curve that was done.

While observing Mr Hill teach the section on Electromagnetic Radiation,

> *"When calculating frequency two equations can be used. (The teacher wrote equations on the board, $v = f\lambda$ and $T = 1/f$). However with EMR, we substitute c in place of V and manipulate the equation with the energy $E = hf$."*
>
> *"Use the exponential form for these calculations on you calculator. Everyone take out your calculators".*

It was evident that his content knowledge was not only limited to Physical Sciences but was accompanied by what Baumert et al. (2010), describes as a rich repertoire of mathematical knowledge and skills relating directly to the curriculum, instruction, and learning. Without this the content knowledge of the teacher would have remained inert (Baumert et al., 2010). Mr Hill mathematical knowledge helped him to adapt his Physical Science lesson to a mathematics lesson, during which he taught his learners the skills they required for problem solving as well as skills on how to use the functions of the calculator. Darling-Hammond (2000), posits that when teaching with the aim of developing skills such as problem solving, invention, and application of knowledge, teachers are required to have a deep and flexible knowledge of subject matter. Thus Mr Hill was to help his learners understand the mathematics that was involved in teaching Physical Science.

Contextual knowledge

According to Mr Hill his teaching environment did present him with a challenge,

> *"My teaching environment is not conducive to learning but I make it conducive by keeping the learners involved, constant interaction question and answers."*

The laboratory had desks that were fixed to the ground and arranged in horizontal lines. Learners used benches as seats which made it difficult for group work to be conducted. Hence the teacher alluded to interactions between himself and learners using a question and answer approach as a means of trying to facilitate group discussions and group work for meaningful learning to take place. As it is the responsibility of the teacher to develop activities that allow the learners to meaningfully engage in learning through active participation (Candy, 1991)

Based on Mr Hill's extensive experience and content knowledge, it would have been expected that the learner performance in Physical Sciences would be at the optimum. However this is not the case because Mr Hill clearly described the cognitive levels of his grade 10 learners as being *"satisfactory"*. Mr Hill was of the firm belief his knowledge of subject matter was good and therefore he was equipped to deliver the curriculum. Bandura (1997), states that the beliefs about one's capability to produce certain actions are not the same as beliefs about whether these actions affect outcomes.

Mr Hill had indicated in both his questionnaire and interview responses that factors which frustrated him were,

> *"In the RSA classroom is discipline – it's the first thing you have to address."*

and, this coupled with the laziness, inattentiveness, and a lack of dedication towards the subject from learners hindered his performance as a teacher. In order to address such obstacles Mr Hill alluded to motivating learners. However motivating learners can be difficult if they are living below sub-economic conditions, Mr Hill described the socio-economic status of his learners as,

> *"Most are living under sub-economic conditions."*

Mr Hill tried to create a conducive learning environment by reflecting on his knowledge gained through his years of experience as a teacher in different classroom setting and then tried to adapt it to the current learning context and environment. Thus the teacher tried to model the best teaching and learning situation from his experiences which included,

> *“Good discipline; engage and encourage learners to think.”*

Mr Hill’s had described his best experience of teaching when he taught in London, where the use of technology as teaching aids and a laboratory assistance were readily available to him and hence became actively engaged in the lesson and the acquisition of scientific knowledge through inquiry learning was adequately facilitated (Trowbridge et al., 2008). The task of setting up experiments and video simulations was assigned to the assistance. However in the South African state school classroom this luxury was not available to Mr Hill as he had indicated in his interviews.

Because poor discipline was such a challenging factor according to Mr Hill in the classroom, he always aimed at maintaining good discipline first and foremost, through the use of an autocratic communication style with his learners. This approach certainly did maintain good discipline, during lesson observations the learners were silent and did not engage in minor conversations with their friends, however it failed to create opportunity for the active engagement and encouragement of learners in their learning process.

Other contextual factors that Mr Hill further made reference to was the large class size,

> *“I have 32 learners in my class. The class size is too large, I think 24 learners would be ideal, a small class facilitates practical work.”*

Mr Hill felt that when the class size was small he would be able to provide learners with the individual attention they required and conducting practical lessons would have been easier. Currently Mr Hill conducted his practical lessons as demonstrations because of the large numbers. However he indicated that certain practical lessons were conducted as group work. During the observations of the teacher only one practical lesson was done and it was a teacher demonstration. According to Mr Hill due the class size he could not give learners individual attention in class because having thirty two learners in a South African Physical Science classroom was too large. Based on Mr Hill’s interview responses, his strategy for dealing with learners who had difficulty in their work was,

> *“They need to go and write down their problem, attempt the problem on their own and then come to me with specific questions on areas they need assistance with.”*

The researcher infers that Mr Hill wanted to develop an autonomous learner and he wanted to adopt the delegator style. However his classroom practices and teaching did not develop the skills that the learners need in order to become autonomous learners.

The contextual factor of discipline coupled with an extensive grade 10 Physical Sciences syllabus and poor learner cognition had placed pressure on Mr Hill in terms of his time management for completion of the syllabus.

> *"Physical Science syllabus is vast you got to spend a lot of time teaching and find the time to do the practical work. You have to do more teaching.*
>
> *If learners came in with the required pre-knowledge levels, we would be able to get through the learning material much faster not spending too much teaching for understanding and you will that you will get more time to do more practicals."*

Mr Hill often felt that he had to rush through his syllabus because during his teaching of Physical Sciences, challenges emerged whereby learners could not problem solve due to poor prior mathematical knowledge and this hindered his teaching. This was observed when Mr Hill was teaching learners how to calculate the energy that photons carried, under the section of Electro Magnetic Induction (EMR), some learners did not know how to use the exponential form on the calculator. The teacher then stopped teaching physics and had asked every learner to take out their calculator and explained in a step by step manner how to use the calculator. Thus the teacher had to begin teaching grade nine mathematics and this took up his lesson time as a result the teacher had to make up for time lost.

In Mr Hill's view as much having to repeat basic skills to learners took up time he felt that it also helped to improve the understanding of other learners. It was observed that Mr Hill used mainly the lecturing approach when he wanted to teach learners certain skills and procedures; this approach had worked well because all the learners now knew how to use the scientific functions on the calculator. Since the learners experienced success in learning when the teacher had used this lecturing approach during his teaching; the teacher therefore continued to use it with the occasional question and answer sessions. Lotter et al. (2007) states that when teachers are overworked it becomes very difficult to change that which they believe works well in their classroom. As a result Mr Hill taught his practical lessons also using traditional methods of teaching.

Teacher's Knowledge of Learners Understanding

Being attentive, taking notes and attending class was the responsibility of the learner; all of which is built around the concept of transmitting knowledge (Biggs, 2001); this is precisely what My Hill understood a good learner in Physical Sciences to be,

> *"Always prepared, willing to learn; hard working; punctual.*
>
> *At school every day; has every piece of equipment; Hunger for knowledge."*

Therefore how well a learner learnt in Mr Hill's classroom depended on his/her ability, background and motivation; as a result when teaching was not effective it was seen as the fault of the learner (Biggs, 2001). The apathy of the learners impacted on the teacher's instruction. Mr Hill's knowledge of his learners determined how he structured his teaching lessons.

When Mr Hilled was questioned about the cognitive development levels of his learners, he indicated subtly on several occasions that it was not at the expected levels and the learners experienced difficulties in learning Physical Sciences,

> *"NO, that why I say there is big jump, they are not ready."*

His response indicated that the transition from grade nine to grade 10 for learners was not an easy move especially when it came to areas that involved physics and maths.

> *"It is actually slowing you down. Maturity wise these kids cannot cope with the jump from grade nine to grade 10. It is a big jump."*

Yet the teacher made no attempt to allow for the learners to engage in group activities and build their own understanding during lessons. Group work facilitates learning through social interaction and it allows for learners to build on their existing knowledge. Although his lessons involved the use of the text book and occasional worksheets, learners had to work on their own, there was no evidence of group work. Because of the elimination of group work from the researcher infers that Mr Hill's classroom practice did not adopt the social constructivist view of learning. This involves learners engaging with each other and building on each other skills and knowledge through cooperative learning, thus achieving fundamental thinking skills to science, such as creative and critical thinking, decision making and designing, leading to problem solving are shared amongst learners from various different societies (Mchunu, 2012). Mr Hill, did not provide opportunities for his learners to scaffold their learning nor construct scientific theories based on human intellect (Driver, 1983).

The teacher's understanding of his learners difficulties were triangulated during lesson observations.

> *"When calculating frequency two equations can be used. (The teacher wrote equations on the board, $v = f\lambda$ and $T = 1/f$). However with EMR, we substitute c in place of V and manipulate the equation with the energy $E = hf$."*

> *"Use the exponential form for these calculations on your calculator. Everyone take out your calculators."*

As the teacher walked around his class, with the expectation that the learners would have been able to solve the example he had on the board, however he found that many of the learners in Mr Hill's class were unable to manipulate the equations and further to this they did not know how to use the scientific functions on the calculator. To rectify the situation, Mr Hill had interrupted the learners (while they were busy attempting to find the answer to the example that was on the board) and asked each child to pick up their calculator, and began telling them which buttons to press. This unplanned activity took up about twenty five minutes of the teaching period. Hence Mr Hill responded that,

> *"The mathematics hasn't been taught very well in the lower grades and for many learners it is a very big jump going from grade nine to grade 10."*

Because Physical Sciences also involves a fair amount of mathematics, Mr Hill's knowledge of mathematics allowed him to adapt his lessons to the needs of his learners.

Mr Hill understood that his learners experienced difficulty in learning Physical Sciences, yet not all them were prepared to put in the extra effort that was required. He alluded to importance of learners a good conceptual understanding of certain concepts that carried over to grade eleven and grade twelve. However Mr Hill was aware that some learners just did not listen neither did they complete their class activities at home? The tardiness of such learners reflected in their results.

> *"It is not actually homework, but a spill over of classwork. I tell the learners complete it at home and we will go through it in the next lesson No, I would say about fifty to sixty percent do the*

homework and the others loaf. And it's evident in their results at the end of the year".

"Putting more time into the studies will benefit the learner. Often learners come to me and say I don't understand and I say go home read over it and come back tomorrow with questions on what you don't understand. Learners who do this and working on their own are performing far better than those who don't."

Because of Mr Hill's expert skills that were acquired and developed through his years of formal training and reflection on his teaching experiences (Grossman, Schoenfield, and Lee, 2005), it made him knowledgeable of the common misconceptions that learners would have. Therefore when it came to answering questions, and he was able to point out their errors and correct it instantaneously,

"Gas is when atoms have large spaces between them, liquid has smaller spaces between then and solid has no spaces between them. (Learner response)"

What do you mean when you say between them?

The particles that make up the matter have spaces between them. (Learner response)

Good, please answer using correct terminology because at grade 10 you will be marked down for vague answers.

The researcher infers that Mr Hill's knowledge of the structure and syntax of Physical Sciences allowed him to effectively use instructional techniques (for example the question and answer approach) to start his lesson so that he would be able to gauge the prior knowledge of learners. It also allowed for Mr Hill to get a better understanding of how his learners responded to questions using scientific terminology.

Teacher Beliefs

It was the belief of Mr Hill that a good teacher is one that,

"Is committed and dedicated, well versed in technological skills (comp, smartboard) has a desire for his/her learners to succeed, love and passion for teaching."

He was of the firm belief he was well trained in the content of the grade 10 syllabus and therefore his self-efficiency belief was high. It is theorized by Caprara, Barbaranelli, Steca, and Malone (2006), teachers with a high self-efficiency are more likely to improve learner achievement in the classroom, through the use of effective classroom management, and adopting teaching strategies that allow for the development of an autonomous learner who is motivated and dedicated to the task at hand. Mr Hill maintained good classroom management through the use of his autocratic communication style, however his classroom practice involved a tremendous amount of lecturing, question and answer sessions and demonstrations.

Mr Hill, became a teacher because he describes it as,

"It was a calling"

Therefore Mr Hill had an intrinsic motivation to teaching, he did it because of the pleasure and satisfaction that accompanied the action (Ryan, Connell and Deci, 1985). He wanted his learners to be motivated because he believed that when they are motivated they will be dedicated. His belief to doing well in Physical Sciences was through,

"Practice, practice, practice!"

In order for learners to attempt activities in Physical Sciences they would have had to have some conceptual understanding of the content of work they are dealing with, and then apply this theory to application. Learners would have a greater motivation only when they have experienced some form of success. However, Mr Hill believed that issues of discipline created a hindrance to his teaching, and it resulted in him sending learners out of the class. It is against regulation to send learners out the class due to poor behaviour, thus Mr Hill adopted his autocratic approach in his class. This style of communication impacted on his communication with his learners because this communication style of the teacher with his learners, was associated with the learner's motivational orientation (Noels, Clément, and Pelletier, 1999). Sending learners out of class for poor behaviour would have not only embarrassed the learner but also demotivated the learner. In being so head strong in his beliefs the teacher failed to realize that learners would encounter difficulty in putting theory into practice if their conceptual understanding was poor.

Analyzing the type of instruction that he adopted during his lessons he did not in fact develop an autonomous learner. According to the Self-Determination Theory the motivation of learners is influenced by factors (such as the teacher) in the social setting (in this case the Physical Science classroom) that affect the self-perceptions of competence and autonomy (Noels et al., 1999).

Mr Hill's belief on learning was,

“Learning is when a child is able to do things on their own.”

But the teacher did not create learning opportunities for the learners to do things on their own. Practical activities and group work sessions can create opportunities for learners to work on their own. However the teacher did not do practicals frequently when he did do it, it was done as a demonstration. Group work was non-existent in the teacher’s classroom because of his autocratic approach when teaching,

Mr Hill conceptual understanding of inquiry teaching was,

Asking questions.

Inquiry teaching is practised when the teacher is able to teach Physical Science using an inquiry approach which involves the active participation of learners in scientific investigations/practical lessons which provide them with opportunities to explore possible solutions, explain phenomena, elaborate on potential outcomes, and evaluate findings (Gillies and Nichols, 2015). However Mr Hill was in fact using the traditional method of teaching. According to Redish, Saul, and Steinberg (2000), traditional physics teaching is in fact ineffective in helping learners develop a more scientific view and conceptual understanding of physics.

He further alluded to teaching Physical Sciences through,

“Self-discovery is the ideal way for teaching physics. Science is all about testing theories.”

To Mr Hill, learners posing questions to him or vice versa was considered inquiry teaching. For the teaching and learning of Science scientific inquiry involves identifying and posing questions, designing and conducting investigations, analyzing data and evidence, using models and explanations, and communicating finding (Keys and Bryan, 2001). This alludes to an extensive amount of practical work and experiments being conducted in the classroom, with learners being actively involved and conducting such experiments. Clearly from observing Mr Hill’s classroom instruction it did not match his beliefs about teaching Physical Sciences.

Mr Hill described his best teaching experience of Physical Sciences when he was based at a school in London. Mr Hill alluded to the extensive use of technology and video simulations that was used as teaching aids during his lessons. Goddard, Hoy, and Hoy (2000), infer that the teacher’s beliefs influences his learning environment. Mr Hill beliefs on the use of such technology helped to enhance his teaching, his learners understanding. Beichner and Dancy (2006), state that the technological applications is in fact an asset to learning and assessment because it allows for learners to be actively engaged and further facilitates communication that would otherwise be difficult or impossible.

However Mr Hill, failed to take cognisance that he was now teaching in a South African classroom. He also added that the availability of a laboratory assistant made his teaching experience a lot easier; the assistant ensured that all teaching aids were set up before he got to the class, all that was required was for him to deliver the lesson. Thus Mr Hill insinuated that because he had help on the logistics, no contact time between him and his learners were lost setting up for the lesson.

Based on Mr Hill's description of his best teaching experience, it appears to have such a tremendous impact on him that he is still adopting the same methodology of teaching that he used over three decades ago in a classroom that was well resourced (with the required equipment and technology together with a laboratory assistant to set-up for practical lessons) in terms of teaching aids. Richardson (1996), states that teachers' beliefs originate from their life experiences. Mr Hill is currently over the age of sixty, and his experiences that have contributed to the formation of strong and enduring beliefs he has about teaching and learning come from different stages of his educational career (Richardson, 1996). These experiences include personal experiences, experiences with schooling and instruction, and experiences with formal knowledge (Richardson, 1996).

Professional Development

Mr Hill indicated that there was no grade 10 Physical Sciences workshops. All that was planned had focused on grade twelve. Yet it is grade 10 that lays the foundation.

> *The workshop focus is grade twelve.*
>
> *There is no workshop in term four.*

Mr Hill's understanding of professional development was as follows,

> *"I) being efficient in all aspects of teaching"*
> *"II) Coming to terms with the mandate that is given to you by the subject advisor, they set down guidelines to follow given by the department and the teacher must follow it and live up to it."*

Examining statement (I) above of Mr Hill, he was aware that to be a teacher in the South African classroom development was required along three dimensions simultaneously: content knowledge, teaching approaches and professional attitudes (Kriek and Grayson 2009).

Mr Hill's statement (II) indicated that he understood professional development as teachers' acknowledging the policy documents which clearly indicated what was required to be taught, assessments to be completed and the timeline for which it was to completed in. The Curriculum and Assessment Policy Statement for Physical Sciences states that Physical Sciences is a subject that “promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships” (DBE, 2011, p. 8). From observations of Mr Hill his classroom practices did not promote the development of scientific inquiry in learners. Avalos (2011), was of the view that professional development for teachers must encompasses teacher learning, learning how to learn and transforming their knowledge into practice for the benefit of the growth of their learners, and not only necessitate teacher understanding of policy documents.

In Mr Hill’s questionnaire responses he indicated that professional development also entailed,

> *“III) Interaction with colleagues also is part of professional development.”*
>
> *“IV) They are important because certain standards have been set and the teacher has to make those standards. Practice makes perfect”*

Mr Hill’s understanding of professional development also included interaction with other Physical Science teachers. Such interaction would have allowed for these teacher’s to share pedagogies appropriate for teaching grade 10 Physical Sciences. Although the teacher had attended workshops, its focus was grade twelve. The pedagogies that a teacher may use to teach grade twelve mechanics would differ from that the teacher would use to teach grade 10 mechanics for the simple reason that the cognitive developmental levels of learners in the two grades differ. Mr Hill had many years of experience and excellent subject matter knowledge as a teacher; but in in order for him to have been able to engage his learners in collaborative discussions to communicate scientific ideas, he required the chance to participate in professional learning thus allowing him the opportunity to learn different pedagogies appropriate for teaching Physical Sciences at the grade 10 level (Duschl and Gitomer, 1991).

While observations of Mr Hill in practice in the classroom demonstrated that he did possess excellent content knowledge; he would have still liked to engage in professional development. He would have liked professional development programmes to be structured based on the National Diagnostic Reports of examiners for the National papers that are written at the end of each academic year.

> *“Look at the examiner’s report and look at what the problems are and deal with the identified*

issues. Print material for teachers to improve their content knowledge."

By studying such reports the subject advisors would be able to present teachers with material that improved their content knowledge. The teacher felt this was essential because teachers' content knowledge and conceptual understanding of the subject has to be good in order to develop the learners' conceptual understanding of Physical Sciences. Borko (2004), states that teachers must have rich and flexible knowledge of the subject. Mr Hill also was of the view that professional development programmes must make teachers' aware of the common errors that learners in a South African classroom are prone to making in Physical Sciences.

From Mr Hill responses the professional development that he did attend thus far was in fact not catering for his needs as a teacher,

> *"(Researcher) Do the workshops train you in terms of practicals?"*
>
> *"No. The workshops do not physically do the practicals. Since 2007 there was only one occasion where practical work was actually done at a workshop."*
>
> *"The disadvantage I find these days is some of the equipment for practicals is so advanced even I don't know how to use it, yet I am an experienced teacher."*

The professional development workshops that Mr Hill attended firstly did not meet his needs as a teacher. Kwok (2014) states that for professional development programmes to be effective is must address the concerns and needs of teachers. Secondly, Mr Hill indicated that he had found difficulty in the use of practical equipment, particularly new modern equipment. The teacher made reference to attending one workshop in 2007, where practical work was physically done. However Guskey (1986), Howey and Joyce (1978), McLaughlin and Marsh (1978), and Wood and Thompson (1980) have indicated that such once off professional development programmes are in fact ineffective.

> *"What the department should do is, do practical lessons on a regular basis with their science teachers, teach them how to use the new equipment that becomes available."*

As a teacher Mr Hill has been exposed to traditional professional development workshops, which was fragmented, de-contextualized, incoherent and very isolated from the real classroom situations (Kelleher, 2003). It did not have any improvement on his classroom teaching practice, hence the teacher alluded to having workshops that developed his practical skills and made him knowledgeable on the use of modernized practical equipment.

Mr Hill had indicated that he was coming to the end of his reign as a teacher and a novice teacher was shadowing him during his teaching. In order for her to build her capacity as a teacher Mr Hill gave the following response to the researcher's question,

> *"R – Will Professional Development which includes theory as well as practical work, result in improved teacher performance?"*
>
> *"Exactly. Both components are required."*

He was of the firm belief that attending professional development workshops which included teacher practical training programmes and teacher content training programmes for grade 10 Physical Sciences would improve the content knowledge, teaching pedagogies and practical application skills of novice teachers and experienced teachers. Guskey (2002) reiterates that professional development is to change a teacher's classroom practice, which in turn changes their beliefs and attitudes, however this type of change does not happen spontaneously, therefore it needs to be on going.

5.4.3. Findings

The outcomes of this study are to understand how the experiences of the teacher influence the classroom practice of the teacher.

TEACHER KNOWLEDGE

Mr Hill had decades of experience in teaching Physical Science. Therefore his subject matter knowledge was extensive and broad. Mr Hill had the ability to alternate from being a Physical Science specialist to a Math specialist when the need arose in his classroom. The teacher's broad knowledge had assisted him in addressing his learner's poor mathematical skills. The teacher was able to make use of analogies and examples that learners could relate to during his teaching thereby making learning meaningful in his classroom.

An extensive syllabus together with poor learner discipline resulted in the teacher using an autocratic management style in his classroom. This cascaded onto the type on classroom practices he had used. Mr Hill's lessons did not facilitate learning along the social constructivist plane, rather is was more lecturing with the teacher being the sole provider of information and facts. Consequently with the continued use of classroom practices that involved activities and examples that did not engage learners in the learning process, the conceptual understanding of basic concepts and skills in learners was not well developed.

TEACHER BELIEFS

Mr Hill was firmly rooted in his beliefs that learners who took up Physical Sciences, need to be self-motivated and dedicated in order to have success. Therefore Mr Hill's adopted a delegator style of teaching. Mr Hill believed that to learn Physical Sciences it required extensive practice from the learners. However some learners did not do classwork and/ homework because of their poor conceptual understanding. The teacher's classroom practices entailed lecturing new content to his learners. Hence the researcher concludes that Mr Hill's pedagogical approaches to teaching Physical Sciences was in fact poor and therefore the skills that CAPS envisaged learners to develop would in fact not be developed.

Mr Hill believed by engaging in basic question and answer sessions and conducting practical lessons as demonstrations he was making use of the inquiry approach to teaching Physical Sciences. Consequently the teachers understanding of what inquiry teaching was and what it actually entailed was blurred.

PROFESSIONAL DEVELOPMENT

The professional development offered to the teachers in the selected district in KZN occurred once a year. This professional development did however not focus on grade 10. Mr Hill's content knowledge in the subject was fairly good and substantial. However, it was his ability to bring across such knowledge to his learners that was a problem. Mr Hill's teaching approaches and methodologies were not well developed. Therefore Mr Hill felt that ideally professional development programmes should be structured in a manner that incorporates the examiner's report from the preceding year matric exam. These reports provide details of areas in physics in chemistry that are most poorly answered in the grade twelve final National Senior Certificate Examination. Thus a lack of professional development impacted on the PCK of this experienced teacher.

Mr Hill stated that due to the advances in technology in terms of equipment he was unable to use them for practical lessons because he did not how to use it. Consequently Mr Hill's classroom practice was limited to teaching a practical lesson as a theoretical lesson; i.e. learners are given a set of results and asked to interpret it. Therefore professional development is essential and must be planned according to the needs of teachers. The researcher therefore infers that for a teacher to be effective in the classroom, theoretical knowledge and practical skills are equally important; else the skills that the Department envisages learners to achieve at the end of the academic year will certainly not be accomplished.

Professional development is therefore essential for effective teaching and learning to take place in a Physical Science classroom (as illustrated in figure 10).

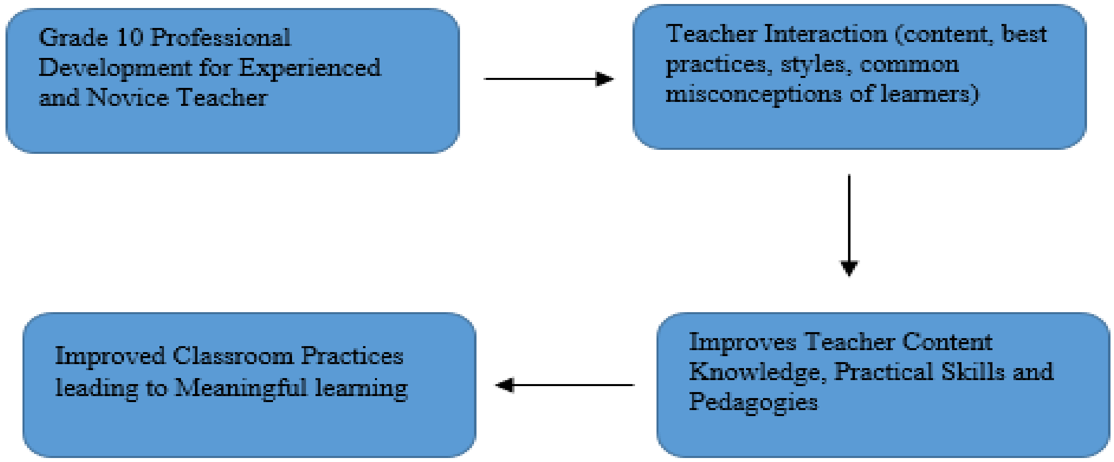


Figure 10: Diagram illustrating the effect of Professional Development on Teacher Classroom Practice and Learning

When there is poor professional development, no opportunity for peer teaching and a lack of support given to teachers, then frustration gets the better of them, which ultimately affects their classroom practices. Had Mr Hill been knowledgeable regarding the types of explanatory frameworks and how to use them, his classroom instruction would have been more engaging to learners and not solely a lecturing approach, and ultimately leading to quality leaning which is the means to the end.

If grade 10 is emphasized as creating the foundation to grade twelve, then district officials need to give grade 10 Physical Sciences more attention. Mr Hill was content knowledge was extensive, he could integrate concepts of Physical Sciences to the daily life of learners; and he was competent in other areas such as mathematics that leant itself to Physical Sciences. However his classroom practice was limited. Therefore critical scientific skills were not developed in Mr Hill learners. If Mr Hill had the opportunity to engage in Professional development programmes (as illustrated in the Diagram above figure 10) that focused on grade 10 content knowledge and alternative methods of delivery of the content using the inquiry approach, then his classroom practice would have ultimately creating learning opportunities for learners to be actively engaged in the lesson. By capturing the attention of the learners, Mr Hill would have automatically eliminated the problem of discipline from his classroom and therefore his communication would have not been autocratic.

5.5. CHAPTER CONCLUSION

This chapter presented the data collected for the purpose of this study. Data were presented in a tabular format. Only aspects deemed relevant to answering the research questions were included in the presentation. Each data presentation is followed by a comprehensive discussed, and findings are then made. The next chapter presents answers to the research questions. This chapter also briefly but comprehensively summarise the conclusions and recommendations. The limitations of the study are also presented in this chapter.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

6.1. INTRODUCTION

This chapter provides the answers to the research questions. In addition, the chapter summarises the study findings. Most crucially, the study findings serve to realize the objectives of this research, namely:

- Exploring how teacher knowledge influences classroom practices of teachers.
- Establishing teacher experiences regarding professional development they received.
- Understanding how teacher beliefs influence classroom practices of teachers.

This chapter highlights the contributions this study makes to the general body of knowledge in the teaching and learning of Physical Sciences in South African schools. In addition, the chapter summarises the recommendations it proposes to the various stakeholders including Physical Science teachers, education departmental officials, programme directors and the general educationalist population. The purpose for the recommendations is to lobby the stakeholder base to support the efforts of improving learner performance in Physical Sciences in the FET phase. Recommendations for further research are also suggested, followed by limitations of the study. The limitations of the study were listed to reflect on the shortcomings of the study. This might encourage further improvement of this study by the body of interested researchers out there. The next section summarises the answers to the study's sub-research questions.

6.2. ANSWERS TO THE SUB-RESEARCH QUESTIONS

This research has shown that teachers’ experiences in the classroom influence the delivery of the Physical Sciences curriculum. Teacher experiences could be categorised into teacher knowledge, teacher beliefs and professional development of the teacher.

6.2.1 How does the teacher’s teacher knowledge influence his/her classroom practice in the grade ten class?

CASE 1 – MS AVOS

Ms Avos has been teaching the subject Physical Science for approximately eight years. The researcher classified Ms Avos as a novice teacher because of limited experience in teaching. It was also found that Ms Avos had limited knowledge of the subject matter in Physical Sciences. Ms Avos heavily relied on the traditional methods in her classroom practice in Physical Science. Simply put, Ms Avos predominately relied on lecturing her learners while occasionally and rarely using the questions and answer approach when teaching. It was evident that the poor subject matter knowledge which Ms Avos displayed had some fundamental effect on her classroom practice. For example, Ms Avos would rarely alter or vary her style of teaching. Evidently, Ms Avos' confidence was knocked off for fear of possible embarrassment in front of her learners if she changed her classroom practice approach. Observations were that Ms Avos preferred questions to the learners which would have only required one word answers from the learners. This was to purposefully limit and eliminate any possibilities discussions with the learners, and amongst the learners. Doing so, Ms Avos thus eliminated any chances of teacher-learner debates, interaction and critical thinking to guard against any possible exposure of her poor subject matter knowledge to the learners. Furthermore, Ms Avos also exposed her learners to the risk of poor conceptualisation of Physical Science terminology because of her constant use of incorrect science terminology during her classroom practice. It was simply possible to affect the development of basic concepts in Physical Sciences amongst the learners taught by Ms Avos because of her poor application of classroom practice.

When asked to state her challenges in the teaching of Physical Science, Ms Avos listed as contributory factors:

- An extensive syllabus
- Large class sizes
- Insufficient time
- Poor learner discipline

Although Ms Avos referred to the above mentioned factors as causes of poor classroom practice in the teaching of Physical Sciences, the researcher however concludes that the factors could be corrected. The researcher postulated that if Ms Avos' subject matter on the subject could be improved, and her teaching approaches also bettered, Ms Avos could develop into a better equipped teacher in Physical Science. Observations were that the teacher adopted incorrect and inappropriate classroom practice approaches relying heavily on classroom lecturing. This approach was ineffective because it limited learner participation in class activities. As a result, learners were inactive and bored during Ms Avos' lessons. Some learners became disruptive during lessons. The disruptive behaviour of the learners demotivated Ms Avos to a point of not enjoying teaching the subject. In frustration of the uninterested and disruptive behaviour of the learners during her lessons, and eagerness to maintain order and discipline in class, Ms Avos became authoritative to enforce discipline. In doing so, Ms Avos reasoned that she would be able to complete the extensive grade 10 syllabus within the stipulated time because much of the time was taken away dealing with disruptions of class activities.

Despite this obvious complexity, the teacher still tried hard to assist her learners overcome and move beyond the challenges. The teacher corrected learners' classwork by indicating whether the answer was correct or incorrect. This approach meant that the teacher dictated the answers to the learners without really involving the learners in finding or working out the required answer. This approach detached the learners from the critical moment of learning. An opportunity to improve on learner knowledge and skills was subsequently lost. In other words, the teacher's approach excluded the learners from any possible opportunity to do self-correction where the learner struggled. The teacher was of the belief that her learners had low cognitive abilities in the subject, and that they were lazy to study prior to the content matter being discussed during classroom practice. As a result of learner exclusion from class participation, the teacher therefore eliminated any opportunities which might have led to group work - which is an effective way in teaching and learning.

The teacher effectively missed the opportunity of scaffolding the learners which would have been possible during interactive group discussion amongst the learners. The teacher instead, through her over-emphasis on teacher centred lecturing method fed the learners solutions based only on the teacher's perspective. The teacher became a self-declared expert in the subject. The teacher's style of teaching positioned her as the only expert in that class to provide expert knowledge and problem solving style to a passive learner community. Furthermore, the teacher was aware that her entire learner community comprised second language speakers. Despite her awareness, the teacher still failed to design her classroom practice based on proper and effective analogies and teaching style which would have assisted the learners enhance their understanding of the subject matter. Such actions of the teacher are often dependent on the level of content knowledge. In this case, Ms Avos revealed that she unfortunately also found the content knowledge beyond her reach and understanding. Thus the teacher’s poor content knowledge coupled with a lack of appropriate and effective pedagogical approaches to delivering the content matter might have resulted in poor learner understanding and assimilation of the subject content.

CASE 2 – MS SASSY

Observations were that Ms Sassy had acquired excellent subject matter knowledge in Physical Science garde 10. This knowledge could have been gained from the number of years she had spent in teaching the subject in this grade over the many years of her teaching career. Ms Sassy's extensive subject content knowledge enabled effective classroom practice. The teacher demonstrated better understanding of her learner's cognitive abilities. The teacher's excellent subject matter knowledge and organization of the content during classroom practice, allowed her to be able to link learners' prior knowledge in the subject with new content. In other words, the teacher would build her classroom practice on this. The teacher could fill identified gaps within the prior knowledge of the learners during her classroom practice. Ms Sassy demonstrated excellent knowledge of her subject matter during her classroom practice. Contrary to prior observation, Ms Sassy showed immense skills in the use of analogies during her classroom practice which greatly assisted the development of the conceptual understanding levels of her learners in the subject. Her classroom practices alternated in the main between the expert and delegator styles of teaching, and *vice versa* depending on the needs of her learners. Ms Sassy was aware of the poor cognitive abilities of her learners and sought to compensate the shortcomings by assisting the learners develop proper literacy skills in conceptual formulation for example. Her learners were therefore encouraged to use correct scientific terms when answering questions for instance. Ms Sassy's classroom practice was authoritative.

In this approach, Ms Sassy was exposed to dictation while the learners repeated what she was dictating after her. This way, Ms Sassy tried hard to enforce memorisation amongst her learners. The shortcoming of this approach was that the learners actually failed to develop any scientific understanding of what she was teaching. Evidently, in this regard, Ms Sassy was also persuaded to turn to the traditional approaches in classroom practice. Ms Sassy also used the expert style of classroom practice. Ms Sassy's classroom practice got exposed to ineffectiveness. Non-engagement of the learners cultivated by her use of authoritarian methods and approaches in classroom practice exposed Ms Sassy to ill-discipline of learners in class. It was obvious that learners were getting bored as the classroom practice degenerated into being teacher centred and focused.

On the one hand, Ms Sassy also struggled with large class sizes which impeded personal interactions with the learners during classroom practice. Effectively, individual attention of learners was totally relegated to the background in terms of classroom approaches Ms Sassy would adopt for her practice. Ms Sassy therefore resorted to delegation in some of her classroom practices depending on what was required at that stage. However, Ms Sassy also adopted group work in her classroom practice. Group work involved activities where the learners needed to work in small groups. This allowed learners to take responsibility in their learning. Although the group work approach was a good practice, its effectiveness in this case was greatly hampered by the learners' poor cognitive abilities in the subject matter under discussion. It is difficult to attain any meaningful learning under these conditions. In fact, Ms Sassy, during her preparation for this kind of class activities should have been aware of the complexities involved, and sought for proper ways to address such possibilities. For example, Ms Sassy should have known that the delegator style of teaching focuses on developing an autonomous learner, and based on this, the teacher should have also considered the cognitive ability and maturity of the learner in the respective area of learning before "dumping" group work to the learners (Chilembe and Bruce, 2015).

Furthermore, it was difficult for Ms Sassy to conduct experiments during her classroom practices. Ms Sassy was faced with limited and outdated resources. Conducting of experiments was therefore rare. This had some serious repercussions for classroom practice for the teacher, and subsequently impacted on the learners' knowledge on the subject - especially with regard practical skills. Consequently, this automatically eliminated the teaching of basic skills for problem solving, making observations, collecting, comparing and analysing of data by the learners. The extensive grade 10 syllabus also placed a great deal of pressure on the teacher. Not much time was available for areas of study such as mechanics which would normally require more time. The requirement for the mechanic section of the syllabus according to the ATP is that the section be taught during term four of the school calendar. There is increased pressure during term four because teachers would be beginning to rush in order to cover the syllabus for the on-coming end-of-year examinations.

In a way, this negatively impacted on the learners' conceptual understanding of the section, because, first the teacher is rushing, and secondly, the learners are also under pressure as they begin that season of the end-of-year excitement and preparations. In other words, the focus on this section is disrupted leading to poor knowledge developed in this section. This omission would turn out to have consequential effects on the learners also in future. Grade 10 is supposed to provide foundational mechanics as this section would be reserved for the next grades. If the learners fail to master the concepts in grade 10, the challenge is that these concepts in the grade 10 syllabus get progressively more difficult in the next grades. It is the opinion of this researcher that although the teacher showed some extensive subject matter knowledge, she was however limited by her limited pedagogies in the teaching of Physical Sciences. This shortcoming effectively hindered her skills to adapt her classroom practice to her given context. Her learners became bored and disruptive during classroom practice. Under these conditions, much of her time was spent on managing the subsequent chaos in class rather than teaching and learning. The momentum of the classroom activities was broken and lost. Ms Sassy's classroom practices therefore failed to develop the basic concepts that were required for grade 10 Physical Science. The outcome was failure of any meaningful learning taking place.

CASE 3 – MR HILL

Mr Hill had been teaching grade 10 Physical Sciences for decades. Such experience in the classroom had enhanced his subject matter knowledge in Physical Sciences. Although Mr Hill had years of experience in teaching the subject and in addition excellent subject matter knowledge, he still revealed some considerable shortcomings reflected in his teaching methodology. Mr Hill heavily relied on the traditional approaches in his classroom practices. Mr Hill preferred the lecturing method during teaching hence his pedagogical content knowledge was limited. When conducting experiments in class, Mr Hill would instead personally conduct the experiments for the learners while the learners were relegated into mere uninvolved and passive observers. One would have at least expected Mr Hill to be innovative by involving the learners through group work for example to perform the experiments. The expected scientific skills development and mastering emanating from ability to conduct experiments amongst the learners were severely curtailed. This ability was not developed during Mr Hill's classroom practice in Physical Science. Evidently, Mr Hill's classroom practice failed to facilitate any hands-on learning for the learners. In addition, Mr Hill instead chose to use his excellent content knowledge to build his lesson excluding the learners in the process. In doing so, he behaved like an expert reducing the learners into inactive objects. Evidently, Mr Hill's classroom practice totally removed that opportunity from the learners to be able to apply their critical thinking skills and abilities during his classroom practice. Mr Hill should have demonstrated his long earned classroom practice skills by adopting tailor made classroom instructions that would have encouraged and facilitated critical thinking amongst his learners.

Mr Hill's biggest challenge was managing the large class size. In addition, there was high incidences of poor discipline amongst the learners. Mr Hill consequently resorted to one-dimensional teaching approach; lecturing. This created fundamental complexities in maintaining class discipline and order amongst the learners. Mr Hill's long classroom practice experience came in handy for him during this trying moment of poor discipline which could have easily descended into chaos because he used his experience to normalise the situation. Despite the challenges, Mr Hill still managed to reign on the learners for order. He continued his lessons with much obvious disciplinary difficulties but won the day. Although the teacher maintained fairly good discipline in his classroom, he was let down by his autocratic style of teaching. Interactions were only between him and some active learners but never learner to learner. Learning through social constructivism was effectively eliminated from Mr Hill's classroom practice.

Mr Hill viewed his learners as having poor cognitive abilities in Physical Science, and he therefore adopted the "teacher is the expert" approach in his teaching. This significantly reduced the learners' opportunities to improve their cognitive abilities and skills during his classroom practice. In other words, Mr Hill's classroom practice failed to aid the learners' abilities to assist each other, maybe through scaffolding for example. Mr Hill showed immense knowledge on the areas revealing poor learner mathematical skills regarding the previous grade syllabus. The teacher's extensive mathematical knowledge allowed him to fill in the mathematical gaps that existed in his learners' knowledge which greatly assisted his learners develop the required and expected mathematical skills at this current grade in his learners. In the process, Mr Hill lost a lot of time on this exercise. In compensation, Mr Hill resorted to focusing on time management in order to complete his current syllabus. It became evident that the teacher lost momentum in the process because of the tremendous amount of unidirectional teaching where the teacher became the "expert" telling those who did not have knowledge, reducing the learners into inactive objects thereby totally eliminating any learning through constructivism.

6.2.2 What are the teacher's beliefs on teaching and learning Physical Sciences in grade ten?

CASE 1 – MS AVOS

Ms Avos was a product of the Content Based Education during those years of apartheid education system in South Africa. She was introduced to to lecturing and rote learning during her days as a learner. Ms Avos had experienced some positive results from being taught using these traditional approaches, and on becoming a teacher, she had to borrow from her experiences as a learner to do her classroom practice in Physical Science. Ms Avos therefore encouraged her learners to use rote learning. Critical theories which needed understanding were instead memorised. Evidently, Ms Avos never encouraged learners to develop their questioning skills, and also develop other related skills. This practice undermined the requirements and expectations of the pot-apartheid curriculum statement of CAPS. The scientific skills of the learners were therefore severely impeded. Ms Avos was an ardent believer and theorist of the text-book method which put over emphasis of dictation from the book. Also, lecturing and the traditional method of question and answer methods were considerable adopted. These methods were preferred because they were time-saving making her classroom practice more easier considering the larger class size which Ms Avos had to deal with from time to time. However, Ms Avos ignored the fact that this was achieved at the expense of the learners' who were denied that opportunity to develop required scientific skills and basic science concepts in the subject.

CASE 2 – MS SASSY

Ms Sassy was a direct contrast of Ms Avos with regard teacher beliefs. Ms Sassy believed that classroom practice on Physical Sciences required involvement of the learners. Ms Sassy opined that it was imperative for the teacher to adopt a liberal approach in classroom activities which would promote that "hands on activities" involving experiments and research conducted by learners. Surprisingly however was that despite this fundamental belief, Ms Sassy would never implement her beliefs in her classroom practices. Ms Sassy's classroom practice instead focused on the development of autonomous learners without taking into account the maturity of her grade 10 learners. All what Ms Sassy had was a history of methodological approaches in the teaching of Physical Sciences which she had acquired from her mentor of some 30 years ago. Ms Sassy's involvement of learners during classroom practice was sporadic preferring to keep to the traditional way of classroom practice. She however remained a hardened conservative of the old order apartheid era education in South Africa which promoted lesser learner involvement in classroom practice. Evidently, the teacher was mentored under the apartheid education system with special focus on the traditional content based curriculum. Therefore the teacher's beliefs impacted on how she performed her classroom practice even beyond the apartheid education system.

CASE 3 – MR HILL

Observations were that Mr Hill has had some teaching experience outside South Africa, precisely the United Kingdom (UK). The experience gained in the UK greatly influenced Mr Hill's beliefs in the teaching and learning of Physical Science. However, it was always going to require a deal of effort for Mr Hill to implement his beliefs in a completely different classroom environment in South Africa to that of the UK. The contextual factors between the two education systems were expected to be materially and significantly different. The South African environment - especially as it affects Mr Hill's school and grade in Physical Science would for various intertwined factors not be conducive for the implementation of the best classroom practices similar to those he might have initiated to while in the UK. First and foremost, the UK set-up was that of a private school while his new environment in South Africa would be that of a public school. Because the teacher was accustomed to the luxury of a laboratory assistant for setting up practical lessons and experiments during classroom practice in the UK, and the use of video simulations to aid experimental explanations, Mr Hill was to find it very difficult to adapt his teaching which apparently would not have such luxuries in South Africa. The teacher believed that learners of Physical Sciences need to be autonomous in their learning. Mr Hill believed in structuring his classroom practice to give space to the learners to take charge of their own learning. Despite these efforts, still Mr Hill's classroom practices failed to achieve meaningful learning. The shortcoming was that Mr Hill had over-emphasis on maintaining classroom discipline amongst his learners. His autocratic teaching approach impeded learner interaction, group activities and open discussions. Mr

Hill's classroom practice impeded open communication during lessons, and therefore exposed his practice to curtailing meaningful learning.

6.2.3 What is the nature of the professional development for the grade ten Physical Science teacher?

CASE 1 – MS AVOS

Ms Avos had never been to any professional development training for teachers of Physical Science in grade 10. Lack of this training was evident in some of Ms Avos' classroom practices. For example, Ms Avos confused certain areas of learning. Where learners were to conduct experiments in order to answer the posed questions when supplied with data, Ms Avos instead allowed the learners to only answer the questions from the supplied data without having to physically conduct the experiments first on their own. This denied the learners that opportunity to engage in practical work effectively eliminating the chances of the learners acquiring and mastering critical basic skills in the subject. Although Ms Avos' understanding of what inquiry teaching involved, she was however hampered by her incorrect application on this. The apparent lack of Ms Avos' professional development consequently resulted in:

- The stagnation of Ms Avos' beliefs regarding classroom practice of Physical Science. Her classroom practices were characteristically limited to traditional methods such as lecturing and rote learning of learners.
- Poor extension and development of Ms Avos' content knowledge in the subject. It was difficult for Ms Avos to have corrected even certain obvious misconceptions which had existed in her because of her lack of development in the content knowledge in the subject. Despite Ms Avos' apparent lack of content knowledge in the subject, she therefore resorted to the so-called "expert style" of teaching.
- The selection of poor pedagogical approaches in classroom practice as has been demonstrated above.
- The adoption of ineffective classroom practices which regrettably excluded the learners from any active involvement and participation during lessons.
- Bored and disruptive learners during practice because of lack of activity.

The factors listed above would be consequential to creating learning gaps in the learners’ conceptual understanding of Physical Sciences.

CASE 2 – MS SASSY

Observations were that Ms Sassy lacked engagement teacher development activities regarding classroom practice in grade 10 Physical Science curriculum. Despite this limitation, Ms Sassy was however efficient competent in her subject matter knowledge. Ms Sassy displayed extensive depth in the content knowledge on the subject. This factor assisted her confidence during classroom practice. Ms Sassy's delivery of lessons was brilliantly confident. However, the shortcoming was only reflected in her choice of the traditional methods of classroom practice. This pointed to the weakness of the teacher lacking in professional development. Her pedagogical applications were weak and outdated, and needed some development to fit with current and modern classroom practice expectations and requirements. Ms Sassy lacked exposure to engagement with subject colleagues elsewhere where she could learn modern classroom practice approaches fitting the environment. It was observed that Ms Sassy still needed some professional development - especially on conducting of experiments. Had there been some engagement with colleagues in the subject, Ms Sassy would have been better than it was displayed. Such engagements might greatly assist with skills development in areas such as content knowledge, experimentation, identification of common errors and misconceptions in learners. In fact, this assertion was corroborated when Ms Sassy revealed that she was less confident and uncertain on critical sections of the subjects - especially on experimentation and its relevant procedures in particular.

CASE 3 – MR HILL

All professional development trainings the teacher had ever attended only focused on grade 12 Physical Science. In other words, Mr Hill has not received any professional development assistance on grade 10 Physical Science curriculum. Mr Hill revealed difficulties in using new modernized equipment during experiments. As a result he avoided experiments unless such experiments were prescribed. A serious manifestation of this shortcoming was that Mr Hill would therefore only perform some unconvincing demonstrations for the learners. Resultantly, the learners were reduced into inactive spectators during his classroom practices. This seriously negatively impacted on the learners' development of scientific skills in the subject. Another shortcoming reflected in Mr Hill's classroom practices was that he could not sufficiently identify the learning needs of his learners. This detached him from the learners in a way. His classroom practices focused on the development of autonomous learners without recognising that the learners would not cope with his classroom practices, and therefore struggling to grasp the subject matter. Mr Hill however mistakenly reasoned that the struggles of the learners were based on the learners' low cognitive abilities in the subject. In this regard, Mr Hill never realised that the shortcomings hinged on his poor pedagogical applications which obviously needed improvement. This study is of the view that Mr Hill effectively needed improved interactive partnership with colleagues in the subject to improve his professional abilities in crucial areas of subject content knowledge and selection of appropriate pedagogical approaches for classroom practice in the subject.

6.3 ANSWER TO THE MAIN RESEARCH QUESTION: WHAT ARE THE EXPERIENCES OF TEACHERS IN IMPLEMENTING THE PHYSICAL SCIENCE CURRICULUM IN A GRADE 10 CLASS?

This study concludes that teacher content knowledge, teacher beliefs in the teaching and learning of Physical Sciences and the professional development of the teacher influence both classroom practices of the teacher, and subsequently the ability of learners to develop their basic concepts and skills in the subject. The South African Physical Science classroom is comprised of extensive and widely diversity population of students. To be able to cater for this broad Physical Science learnership, and to meet its departmental imperatives in the teaching and learning of sciences post-apartheid, and to promote its targets of achieving equality amongst all racial groups in education, the South African Education system needs to equip itself with well developed, skilled and equipped Physical Science teachers. Teacher professional development in content knowledge, pedagogical application and effective and efficient classroom practice skills are inevitably required. The education authorities have to ensure that capable teachers equipped with proper and best classroom practices skills which would cater for the needs of the broad-based learner population of different abilities are continuously developed.

As matters currently are, Physical Science teachers in grade 10 were preoccupied by syllabus completion only rather than achievement of meaningful teaching and learning. However, on the positive is that there are few cases where in some schools experienced Physical Science teachers would provide mentorship to the younger teaching cohort. This interaction allows for sharing of experience and transfer of skills and knowledge to the younger teacher cohort while the older cohort gains skills in new technology for example. However, the negative might be that if the older teachers passed on negative experiences and misconceptions to these novice teachers, the newer teachers might instead develop negative beliefs in the teaching and learning of Physical Sciences therefore corrupting the whole system. Such transfers of negativity might be identified in the nature of end-of-year grade 12 Physical Science results. The poor performance of learners in the grade 12 National Senior Certificate is constantly questioned, yet the Diagnostic Reports on the results always indicated that the majority of candidates in these examinations answered questions on basic concepts in Physical Sciences very poorly. Evidently, reflections in this examination performances of the learners would reveal direct link with the poor conceptualisation tendencies and phase amongst grade 10 Physical Science learners. These basic concepts are actually tested in grade 12 examinations having however been built from the grade 10 curriculum. Poor performance of Physical Science grade 12 in this regard would have been "inherited" from the poor understanding of this section in grade 10. Lack of teacher professional development with regard those areas in grade 10 would not be entirely removed from the cause list of factors resulting into the performance in grade 12. In addition, it should be noted that the teachers in this study in grade 10 had revealed that one of the biggest challenge was completion of syllabus in grade 10 because of inadequate time. This is reflected in grade 12.

6.4 MAIN CONTRIBUTION OF THE STUDY

INTENSIVE CARE PROFESSIONAL DEVELOPMENT (ICPD) MODEL

Ongoing professional development of the teacher is critical if meaningful learning were to be achieved in grade 10 Physical Science in South African schools. Based on the findings in this study, this researcher therefore proposes a Model called the Intensive Care Professional Development (ICPD) Model (Figure 11) meant to improve teacher development in grade 10 Physical Sciences in South Africa. When teachers are engaged in well-structured professional development which considers their professional needs for classroom practice in Physical Science grade 10, teacher beliefs might be reshaped towards new modern approaches in classroom practice. Meaningful learning might be achieved in the process unlike when the teacher stays dormant within the traditional methods of classroom practice.

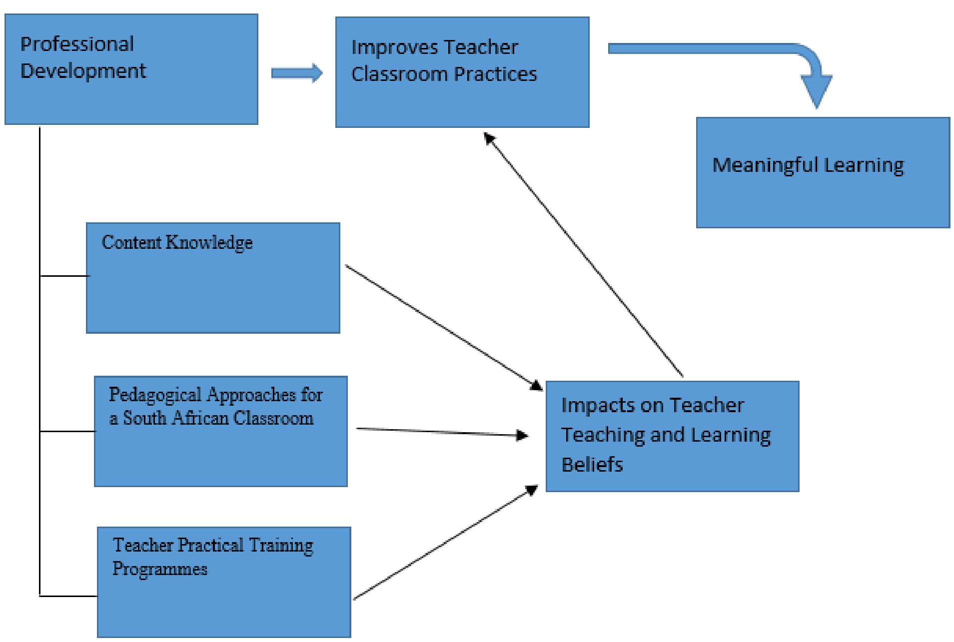


Figure 11: Intensive Care Professional Development (ICPD) Model for Grade Ten Physical Sciences Teachers in a South African Classroom

This model is aimed at developing teachers in content knowledge and classroom practice skills required for effective teaching and learning of Physical Science grade 10 classroom. Such development might assist development of teacher experiences in the teaching of Physical Science, therefore leading to meaningful learning amongst learners. For long term improvement of the National Senior Certificate results in Physical Sciences grade 12 for example, intervention should be effected in grade 10. Simply put, this assertion postulates that the grade 12 learner must have been thoroughly introduced to basic concepts in Physical Science in grade 10. Comments given by external moderators and markers in the Diagnostic Reports from National Examinations must also be reviewed. These comments should also be taken into account when developing the programme content for grade 10 Physical Science curriculum. The ICPD Model should be initially adopted per school term. This could be continued repeatedly over time until such time that substantial improvement of learner performance is evident in the grade 10 results. The frequency of adoption of this model could however be reduced, but in the process, this adoption should stay consistent throughout the academic year.

Currently schools in the selected district write standardized quarterly examinations. This practice is meant to assist the department of education to keep abreast of learner performance in the district. The programme must ensure active engagement of teachers (with concrete teaching tasks that are based on their actual experiences with learners) and at the end each academic term feedback on learner performance should be relayed to the district education authorities.

Professional development programmes for the teachers must cater for three areas of teacher needs as per the ICPD model:

- Teacher content knowledge: this must focus on Physical Science content. Some specific areas of mathematics which could be required for the teaching of Physical Sciences could also be included in the package. Improving teacher's content knowledge will give the novice teacher more confidence during classroom practice in the subject. On the one hand, experienced teachers will be able to share their use of analogies for varying sections thus aiding teacher conceptual understanding in the subject. This is expected to improve the understanding of concepts.

- Pedagogical approaches in classroom practice: Because of the varying contextual factors that could be impeding on classroom practice of the teacher, teachers should therefore be given the opportunity to share as colleagues their teaching approaches and styles during classroom practice. In developing the teachers, teachers would therefore need to be taught in the same way as the learners would in a normal Physical Science classroom. This assertion suggests that if the principles of OBE, where learners are expected to learn through active involvement in their learning process could effectively produce the desired outcomes on the learners, the same OBE principles could still be exported to assist in teacher professional development programmes on the teachers. Teachers need to be made aware of the different styles and approaches to classroom practice in Physical Sciences. The teachers should also be conscious of the factors involved in classroom practice in the subject. Although the teachers; for example teachers in Case two and Case three in this report had good intentions by adopting the delegator style of teaching in their respective classroom practices which they thought would enhance learner autonomy, these good intentions were however impeded by the teachers' lack of understanding of the other factors involved. For example, in these two cases, the teachers obviously failed to understand that for them to develop an autonomous learner, factors such as the maturity of the child had to be taken into consideration. This assertion is corroborated by Chilembe and Bruce (2015). The teachers were aware that the learners were not at the required cognitive levels for grade 10 Physical Sciences. Teachers need to engage with colleagues to share experiences and best pedagogical practices and strategies for varying contexts. This is critical considering that at grade 10, the teachers are actually dealing with young minds which need some proper handling. These learners are vulnerable because they are "new" in the subject of Physical Sciences.

- Teacher Practical Training Programmes: The CAPS stipulate that Physical Science must involve the inquiry approach. To teach learners scientific skills of conducting practical lessons, analysing results and drawing conclusions, teachers must be knowledgeable enough with regard the use of equipment, application of required skills and safety precautions - especially during experimentations. Novice teachers tend to avoid conducting practical lessons during their classroom practices because of lack of proper knowledge. Therefore professional development programmes that focus on these teachers conducting practical lessons are necessary, and needed to be encouraged. This might bridge the gap between theory and practice.

As has been mentioned above, these programmes are essential for teacher improvement of content knowledge and concept understanding in Physical Science. Proper pedagogical approaches could also be developed in teachers. This development is expected to improve teacher classroom practice skills and abilities to develop and present effective teaching and learning. Learners would also benefit immensely by the development of these skills because they would start to be actively engaged during classroom practices as participants rather than inactive objects. Learner attention during classroom practice would also be improved, and under these circumstances, the learners' scientific skills as prescribed by CAPS in the subject would be enhanced and ensured. As David and Krajcik (2008) state that curriculum material could provide teachers with support that favours improved scientific practice during classroom practice, the teacher should also demonstrate implacable management skills and abilities. The ICPD model becomes inevitable tool to meet this expectation.

The application of this ICPD Model would reveal its effectiveness is assisting the teacher in the teacher's improvement of classroom practice. The proposed ICPD Model also opines that such teacher professional development is also cascaded onto the teachers' classroom practice beliefs. This research study found that practical teaching was highly limited in the cases. Also, the classroom practices of teachers were often and highly dependent and centralised on the teacher's content knowledge without any significant involvement of the learners. Teachers over-exhausted traditional methods. Evidently, the teachers were uncertain on how to conduct experiments during classroom practices. The confidence on practical work and experiments was too low for a grade 10 Physical Science curriculum in a South African school context.

This study concurred with the results of previous researchers that the beliefs of a teacher would be very difficult to change. To change the beliefs of teachers in classroom practice as it involves Physical Science curriculum in South African schools would require the Department of Education to engage in effective and efficient teacher professional development programmes. Experts in the subject need to be enlisted. Allowing teachers to experience success build their confidence in such practices, improves the chances of them using the inquiry approach to teaching. Hence changing their beliefs on their classroom practices. Consequently basic skills and concepts (e.g. use of a thermometer, understanding the error of parallax for example) that learners are expected to learn in grade 10 might not be eliminated. The added advantage of this practice is that teachers need to be knowledgeable of the potential dangers of the chemicals and equipment they are using in the classroom. Consequently enabling them to advise learners of what precautions' need to be taken when using certain chemicals.

According to Maslow's hierarchy, when the basic needs (in this case the safety of the teacher and the learners under his/her care, when working with chemicals) are met then self-fulfilment needs which include self-actualization of achieving one's full potential can also be met (Woolfolk, 2007). By developing the practical application skills of a teacher, content knowledge and pedagogical knowledge, the teacher gains motivation. When this occurs the teacher's approaches to teaching will change because a knowledgeable teacher will be willing to conduct experiments in class as opposed to a teacher who has uncertainty and lacks in self-confidence. A knowledgeable teacher will have the ability to adapt his/her teaching styles based on the context he/she is presenting. This might lead to improved classroom practice consequently developing basic scientific skills amongst grade 10 learners.

6.5. RECOMMENDATIONS FOR FURTHER STUDIES

This study recommends thus:

- Teacher performance in the classroom be monitored by subject specialists on a regular basis.
- Learner conceptual understanding in the subject be evaluated on a regular basis through standardised tasks.
- A follow-up in-depth study on teacher professional development - specifically on the role of teacher's beliefs in a Physical Science classroom practice context be undertaken in broader South Africa.
- A follow-up study on classroom practices in Physical Sciences in non-state schools be undertaken to have comparatives with government schools because differences are expected to be there based on the two schools' exposure and access to resources and other dynamics such as class sizes for example.

6.6. LIMITATIONS

It is essential to contextualise this study. This study is limited to only one district in the the Kwa-Zulu Natal Province whereas the entire South Africa has plenty of districts and eight other provinces. In other words, the results of this study could not be generalised to the rest of South Africa. In addition, the study only covered schools from the urban areas. In addition, all the selected participant schools were state schools. South Africa also has privately-owned schools. Many novice teachers had declined to be part of this study upon hearing that their classroom practice abilities would also be scrutinised.

REFERENCES

Adams, P. E. & Krockover, G. H. (1997). Beginning science teacher cognition and its origins in the pre-service secondary science teacher programme. *Journal of Research in Science Teaching*, 34(6): 633-653.

Alonso, F., López, G., Manrique, D., & Viñes, J. M. (2005). An instructional model for web-based e-learning education with a blended learning process approach. *British Journal of Educational Technology*, 36(2):217-235.

Anderson, D. (1980). Students in Australian higher education: A study of their social composition since the abolition of fees (No. 23). Australian Government Publishing Service.

Anderson, R. D. (2007). Inquiry as an organizing them for science curricula. In S. K. Abell, and N. G. Lederman (Eds.), Handbook of Research on Science Education. New York: Routledge.

Anthony, G. & Walshaw, M. 2009.Characteristics of effective teaching of mathematics: a view from the west. *Education for All*, 2(2):147-164.

Appleton, K. (2003). How do beginning primary school teachers cope with science? Towards an understanding of science teaching practice. *Research in Science Education*, 33:1 –25.

Arnott, R. O. S. I. E. (1994). A whole school approach to pastoral care: A New Zealand perspective. Caring for children: International perspectives on pastoral care and PSE, 66-75.

Asoko, H. (2000). Learning to teach science in the primary school. Improving science education: The contribution of research, 79-93.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. Teaching and teacher education, 27(1), 10-20.

Babbie, E. (2004). The Practice of Social Research (10th ed.). Belmont, CA: Wadsworth/Thomson Learning.

Badasie, R. B. G. (2014). Managing the professional development of primary school teachers by means of action research (Doctoral dissertation).

Ball, D. L., & Bass, H. (2002, May). Toward a practice-based theory of mathematical knowledge for teaching. In Proceedings of the 2002 annual meeting of the Canadian Mathematics Education Study Group (pp. 3-14). Edmonton Alberta.

Bandura, A. (1997). Self-efficiency: The exercise of control. New York: W. H. Freeman.

Banning, M. (2005). Approaches to teaching: current opinions and related research. *Nurse Education Today*, 25(7):502-508.

Baumert, J., Blum.W., Brunner, M., Lordan, A., Klussman, A., Krauss, S., Kunter, M., Neubrand, M., Tsai, Y., & Voss, T. (2010). Teachers' Mathematical Knowledge, Cognitive Activation in the Classroom, and Student Progress. *American Educational Research Journal,* 47(1):133-180.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. The qualitative report, 13(4), 544-559.

Bayraktar, S. (2009). Misconceptions of Turkish pre-service teachers about force and motion. International Journal of Science and Mathematics Education, 7(2), 273-291.

Bell, B., & Gilbert, J. (1996). Teacher development: A model from science education. London: Falmer.

Bennie, K. & Newstead, K. (1999). Obstacles to implementing a new curriculum. In Proceedings of the National Subject Didactics Symposium (pp. 150-157). University of Stellenbosch, Stellenbosch.

Biggs, J. (2001). The reflective institution: Assuring and enhancing the quality of teaching and learning. Higher education, 41(3), 221-238.

Blachford, P., Bassett, P. & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher-pupil interaction: Differences in relation to pupil prior attainment and primary vs. Secondary schools. *Learning and Instruction*, 21: 715-730.

Bolam, R., McMahon, A., Stoll, L., Thomas, S., Wallace, M., Greenwood, A., Hawkey, K., Ingram, M., Atkinson, A. & Smith, M. (2005). Creating and sustaining effective professional learning communities. London: Universities of Bristol, Bath and London, Institute of Education.

Borko, H. & Putnam, R. (2005). Expanding a teachers knowledge base. New York: Teachers College Press.

Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educational Researcher*, 33(8):3-15.

Bransford, J., Brown, A.L. & Cocking, R.R. (2000). How people learn: brain, mind, experience, and school. Washington, DC: National Academy.

Brickhouse, N.W. & Bodner, G.M. (1992). The beginning science teacher: Classroom narratives of convictions and constraints. *Journal of Research in Science Teaching*, 29:471–485.

Brickhouse, N.W. (1990). Teachers' beliefs about the nature of science and their relationships to classroom practice. *Journal of Teacher Education*, 41:53–62.

Bullough, R. V. (2001). Pedagogical content knowledge circa 1907 and 1987: A study in the history of an idea*. Teaching and Teacher Education*, 17(6):655-666.

Bybee, R. W., Carlson-Powell, J., & Trowbridge, L. W. (2008). Teaching secondary school science: Strategies for developing scientific literacy. Columbus: Pearson/Merrill/Prentice Hall.

Bybee, R., Minstrell, J., & van Zee, E. H. (2000). Inquiring into inquiry learning and teaching in science. Wasington, DC: American Association for the Advancement of Science AAAS.

Calderhead, J., & Robson, M. (1991). Images of teaching: Student teachers' early conceptions of classroom practice. *Teaching and Teacher Education*, 7:1-8.

Candy, P. (1991). Self direction for lifelong learning. San Fransisco: Jossey Bass.

Caprara, G. V., Barbaranelli, C., Steca, P., & Malone, P. S. (2006). Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: A study at the school level. *Journal of School Psychology*, 44(6), 473-490.

Carpenter, T. P., Fennema, E., Petersen, P., and Carey, D. (1988). Teachers' pedagogical content knowledge of students' problem-solving in elementary arithmetic. *Journal for Research in Mathematics Education*, 19:385-401.

Childs, A., & McNicholl, J. (2007). Investigating the relationship between subject content knowledge and pedagogical practice through the analysis of classroom discourse. International Journal of Science Education, 29(13), 1629-1653.

Chilemba, E. B., & Bruce, J. C. (2015). Teaching styles used in Malawian BSN programmes: A survey of nurse educator preferences. Nurse education today, 35(2), e55-e60.

Chin, C. (2006). Classroom interaction in science: Teacher questioning and feedback to students' responses. International journal of science education, 28(11), 1315-1346.

Christie, P. (2005). Leading learning. Cutting edge seminar. Johannesburg. Mathew Goniwe School of Leadership. (Online). Available at: http://www.mgslg.co.za/aboutus/publications/cat_view/57-mgslg-publications.html. (Accessed on 2017/02/02).

Clark, C., & Lampert, M. (1986). The study of teacher thinking: Implications for teacher education. J*ournal of Teacher Education*, 37(5):27-31.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18:947-967.

Cochran, K. F., King, R. A., & DeRuiter, J. A. (1991). Pedagogical content knowledge: A tentative model for teacher preparation. East Lansing, MI: National Centre for Research on Teacher Learning. ERIC Document Reproduction Service No. ED, 340683.

Cohen, D. K., & Hill, H. C. (1998). Instructional policy and classroom performance: The mathematics reform in California.

Cohen, E. G. (1994). Restructuring the classroom: conditions for productive small groups. *Review of Educational Research*, 64:1-35.

Cohen, L., Manion, L., & Morrison, K. (2013). The ethics of educational and social research. In Research methods in education (pp. 99-128). Routledge.

Collins, A. M., & Stevens, A. L. (1980). Goals and Strategies of Interactive Teachers. Bolt Beranek and Newman, Cambridge,Mass. Retrieved from: http://www.dtic.mil/dtic/tr/fulltext/u2/a084114.pdf. Accessed [29 October 2017].

Crawford, B. A. (2000). Embracing the essence of inquiry: new roles for science teachers. *Journal of Research in Science Teaching*, 37:916-937.

Creswell, J. W., & Poth, C. N. (2017). Qualitative inquiry and research design: Choosing among five approaches. Sage publications. United States of America

Dancy, M. H., & Beichner, R. (2006). Impact of animation on assessment of conceptual understanding in physics. Physical review special topics-physics education research, 2(1), 010104.

Darling-Hammond, L. (2000). How teacher education matters. *Journal of Teacher Education*, 51(3):166-173.

Dass, P.M. (1999). Evaluation of a District-wide In-service Professional Development Programme for Teaching Science: Challenges Faced and Lessons Learned. Electronic *Journal of Science Education*, 4:1-19.

Department of Education. (2001). National Strategy for Mathematics, Science and Technology in General and Further Education and Training. Pretoria: Government Printers.

Department of Education. (2002a-C2005). Revised National Curriculum Statement. Pretoria: Government Printers.

Department of Education. (2002b). Revised National Curriculum Statement Grades R–9 (Schools): Policy. Technology Pretoria: Government Printers.

Department of Education. (2003). National Curriculum Statement Grades 10-12. Pretoria: Government Printers.

Department of Education. (2008). National Curriculum Statement. Pretoria: Government Printers.

Department of Education. (2011). Curriculum and Assessment Policy Statement. Further Education and Training Phase Grades 10-12 Physical Science. Pretoria: Government Printers.

Department of Education. (2014). National Diagnostic Report on Learner Performance 2014. Pretoria: Government Printers.

Department of Education. (2015). National Diagnostic Report on Learner Performance 2015. Pretoria: Government Printers.

Department of Education. (2016). National Diagnostic Report on Learner Performance 2016. Pretoria: Government Printers.

Department of Presidency. (2012). National Development Plan 2030 Our Future – make it work. Pretoria: Government Printers.

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis*, 24(2):81-112.

Dhurumraj, T. (2013). Contributory factors to poor learner performance in Physical Sciences in Kwa-Zulu Natal Province with special reference to schools in the Pinetown District. Unpublished Masters Dissertation, University of South Africa, Pretoria.

Drake, C., Spillane, J.P. & Hufferd-Ackles, K. (2001). Storied identities: Teacher learning and subject-matter context. *Journal of Curriculum Studies*, 33(1):1-23.

Driver, R. (1983). The pupil as scientist. Milton Keynes: Open University.

Dudu, W. T. (2017). Facilitating Small-Scale Implementation of Inquiry-Based Teaching: Encounters and Experiences of Experimento Multipliers in One South African Province. *International Journal of Science and Mathematics Education*, 15(4):625-642.

DuFour, R. (2004). What is a" professional learning community"?. Educational leadership, 61(8), 6-11.

Duit, R. (1991). On the Role of Analogies and Metaphors in Learning Science. Institute for Science Education at the University of Kid, Federal Republic of Germany.

Duschl, R. A., & Gitomer, D. H. (1991). Epistemological perspectives on conceptual change: Implications for educational practice. *Journal of Research in Science Teaching*, 28(9):839-858.

Earley, P., & Bubb, M. S. (2004). Leading and managing continuing professional development: Developing people, developing schools. Sage. London.

Eryilmaz, A. (2002). Effects of conceptual assignments and conceptual change discussions on students' misconceptions and achievement regarding force and motion. *Journal of Research in Science Teaching*, 39(10):1001-1015.

Feiman-Nemser, S., & Floden, R. (1986). The cultures of teaching. In M. Wittrock (Ed.), Handbook of Research on Teaching (3rd edition, pp. 505-526). New York: Macmillan.

Fennema, E., & Franke, M. L. (1992). Teachers' knowledge and its impact. Handbook of research on mathematics teaching and learning. New York :Macmillan.

Fosnot, C. T. (1996). Teachers construct constructivism: The center for constructivist teaching/teacher preparation project. In C.T. (ed) Constructivism: Theory, perspectives, and practice (pp. 205-216). New York: Teachers College Press.

Fullan, M., & Pomfret, A. (1977). Research on curriculum and instruction implementation. Review of educational research, 47(2), 335-397.

Gaigher, E., Lederman, N., & Lederman, J. (2014). Knowledge about Inquiry: A study in South African high schools. *International Journal of Science Education*, 36(18): 3125-3147.

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). Educational research: An introduction. Longman Publishing.

Galus, P. (2002). How Standards Enhanced My Teaching Style. *Educational Leadership*, 59(4):77-79.

Geer, U. C., & Rudge, D. W. (2002). Guest editorial: A review of research on constructivist-based strategies for large lecture science classes. *Electronic Journal of Science Education*, 7(2): 1 - 22

Geyer, N. (2008). Reflective practices in foreign language teacher education: A view through micro and macro windows. *Foreign Language Annals,* 41(4):627-638.

Gibbons, P. (2002). Scaffolding language, scaffolding learning: Teaching second language learners in the mainstream classroom. Portsmouth, NH: Heinemann

Gillies, R. M., & Nichols, K. (2015). How to support primary teachers' implementation of inquiry: teachers' reflections on teaching cooperative inquiry-based science. *Research in Science Education*, 45(2):171-191.

Goddard, R. D., Hoy, W. K., & Hoy, A. W. (2000). Collective teacher efficacy: Its meaning, measure, and impact on student achievement. *American Educational Research Journal*, 37(2):479-507.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4):597-606.

Goodrum, D., Hackling, M., Rennie, L. (2001). The status and quality of teaching and learning of science in Australian schools: A research report prepared for the department of education, training and youth affairs. DETYA, Commonwealth Department of Education, Training and Youth Affairs.

Grasha, A.F., (2002). Teaching with Style: A Practical Guide to Enhancing Learning by Understanding Teaching and Learning Styles. Alliance Publishers, CA.

Gray, A. (1997). Constructivist teaching and learning. SSTA Research Centre Report, 97-07. P. Wang (2011, March). Constructivism and Learner Autonomy in Foreign Language Teaching and Learning: To what Extent does Theory Inform Practice, 273-277.

Grossman, P. (2008). Responding to our critics: From crisis to opportunity in research on teacher education. *Journal of Teacher Education*, 59(1):10-23.

Grossman, P. L.(1989). A study in contrast: Sources of pedagogical content knowledge for Secondary English. *Journal of Texiber Education*, 42(5):24-31.

Grossman, P., & Schoenfeld, A. with Lee, C.(2005). Teaching subject matter. Preparing teachers for a changing world: What teachers should learn and be able to do, 201-231.

Grussendorff, S., Booyse, C., & Burroughs, E. (2014). What's in the CAPS package?. Overview report on Umalusi research into the content and character of the Curriculum and Assessment Policy Statements (Department of Basic Education 2012). Pretoria: Umalusi.

Gunstone, R., Mulhall, P., & McKittrick, B. (2009). Physics teachers' perceptions of the difficulty of teaching electricity. *Research in Science Education*, 39(4):515-538.

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, 15(5):5-12.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching*, 8(3):381-391.

Guskey, T. R. (2009). Closing the knowledge gap on effective professional development. Educational horizons, 87(4), 224-233.

Gustafson, B. J., & Rowell, P. M. (1995). Elementary preservice teachers: constructing conceptions about learning science, teaching science and the nature of science. International Journal of Science Education, 17(5), 589-605.

Harris, C. J., & Rooks, D. L. (2010). Managing inquiry-based science: Challenges in enacting complex science instruction in elementary and middle school classrooms. *Journal of Science Teacher Education*, 21(2):227-240.

Hashweh, M. Z. (1987). Effects of subject-matter knowledge in the teaching of biology and physics. T*eaching and Teacher Education*, 3(2):109-120.

Hatch, J.A. (2002). Doing qualitative research in educational settings. New York: State University of New York.

Hausfather, S. (2001, March). Laboratory schools to PDSs: The fall and rise of field experiences in teacher education. *In The Educational Forum*, 65(1):31-39).

Hawley, W.D., & Valli, L. (1999). The essentials of effective professional development: A new consensus. In G. Sykes & L. Darling-Hammond (Eds.), Handbook of Teaching and Policy. New York: Teachers College.

Heeralal, P.J.H. & Dhurumraj, T. (2016). Senior phase science teachers' pedagogic content knowledge of the periodic table: A case study of selected schools in Kwa-Zulu Natal, South Africa. *World Journal of Research and Review*, 3(4):20-24.

Helmke, A. (2009). Instructional quality and teacher professionality: Diagnosis, evaluation, and enhancement of instruction. Seelze-Velber, Germany: Kallmeyer.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2):371-406.

Hofmeyer, J. (2010). Outcomes Based Education is dead...Long Live OBE. University of the Free State. S.A Media.

Holstein, J. A., & Gubrium, J. F. (1995). The active interview (Vol. 37). Sage. United States of America

Howey, K., & Joyce, B. (1978). A data base for future directions in inservice education. Theory Into Practice, 17(3), 206-211.

Ironside, P.M. (2003). New pedagogies for teaching thinking: the lived experiences of students and teachers enacting narrative pedagogy. *Journal of Education,* 42(11): 509–516.

Jita, L.C. & Ndlalane, T.C. (2009). Teacher clusters in South Africa: opportunities and constraints for teacher development and change. *Perspectives in Education*, 27(1): 58-68.

Johnson, S. M. (2009). How best to add value? Strike a balance between the individual and the organization in school reform. Collective Practice Quality Teaching, 7.

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development*, 39(3):5-14.

Kagan, D. M. (1992). Professional growth among pre-service and beginning teachers. *Review of Educational Research*, 62(2):129-169.

Kalman, C. (2009). The need to emphasize epistemology in teaching and research. *Science and Education*, 18(3-4):325-347.

Kelleher, J. (2003). A model for assessment-driven professional development. *Phi delta Kappan*, 84(10):751-756.

Kennedy, M. M. (1998). Education reform and subject matter knowledge. *Journal of Research in Science Teaching*, 35(3):249-263.

Keys, C. W., & Bryan, L. A. (2001). Co-constructing inquiry-based science with teachers: Essential research for lasting reform. Journal of research in science teaching, 38(6), 631-645.

Killion, J. P., & Kaylor, B. (1991). Follow-up: The key to training for transfer. *Journal of Staff Development*, 12(1):64-67.

Kind, V. (2009). Pedagogical content knowledge in science education: perspectives and potential for progress. Studies in science education, 45(2), 169-204.

Kleinman, G. (1965). Teachers' questions and student understanding of science. *Journal of Research in Science Teaching*, 3(4):307-317.

König, J., Blömeke, S., Klein, P., Suhl, U., Busse, A., & Kaiser, G. (2014). Is teachers' general pedagogical knowledge a premise for noticing and interpreting classroom situations? A video-based assessment approach. *Teaching and Teacher Education*, 38:76-88.

Konstantopoulos, S. & Chung, V. (2009). What Are The Long-Term Effects on Small Classes on the Achievement Gap? Evidence from the Lasting Benefit Study. *American Journal of Education*, 116 (1):125-154.

Kriek, J., & Grayson, D. (2009). A holistic professional development model for South African Physical Science teachers. *South African Journal of Education*, 29(2):185-203.

Kwok, P. W. (2014). The role of context in teachers' concerns about the implementation of an innovative curriculum. *Teaching and Teacher Education*, 38:44-55.

Laplante, B. (1997). Teachers' beliefs and instructional strategies in science: Pushing analysis further. *Science Education*, 81:277–294.

Lawson, A.E., Abraham, M.R., and Renne. J.W. (1989). A Theory of Instruction: Using the Learning Cycle to Teach Science Concepts and Thinking Skills. National Association for Research in Science Teaching.

Leach, J., & Scott, P. (2003). Individual and sociocultural views of learning in science education. *Science & Education*, 12(1):91-113.

Lederman, N.G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. *Journal of Research in Science Teaching*, 29:331–359.

Lee, E., & Luft, J. A. (2008). Experienced secondary science teachers' representation of pedagogical content knowledge. *International Journal of Science Education*, 30(10):1343-1363.

Lehrer, K. (1990). Theory of knowledge. Boulder, CO: Westview.

Lehrer, R., & Schauble, L. (2006). Cultivating model-based reasoning in science education. In R. Keith Sawyer (Ed.), Cambridge handbook of the learning sciences (pp. 371–387). Cambridge, MA: Cambridge University.

Leinhardt, G., & Greeno, J. G. (1986). The cognitive skill of teaching. Journal of educational psychology, 78(2), 75.

Lekgoathi, S. P. (2010). The History workshop, teacher development and Outcomes-based education over the past seven years. African Studies, 69(1), 103-123.

Leu, E. (2004). The patterns and purposes of school-based and cluster teacher professional development programmees. Washington, DC: USID.

Looi, C. K., Sun, D., & Xie, W. (2016). Exploring students' progression in an inquiry science curriculum enabled by mobile learning. *IEEE Transactions on Learning Technologies*, 8(1):43-54.

Lortie, D. (1975). Schoolteacher: A sociological study. Chicago: University of Chicago.

Lotter, C., Harwood, W. S., & Bonner, J. J. (2007). The influence of core teaching conceptions on teachers' use of inquiry teaching practices*. Journal of Research in Science Teaching*, 44(9):1318-1347.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., & Hewson, P. W. (Eds.). (2009). Designing professional development for teachers of science and mathematics. Corwin Press.

Loucks-Horsley, S., & Matsumoto, C. (1999). Research on professional development for teachers of mathematics and science: The state of the scene. School science and mathematics, 99(5), 258-271.

Lumpe, A. T., Haney, J. J., & Czerniak, C. M. (2000). Assessing teachers' beliefs about their science teaching context. *Journal of Research in Science Teaching,* 37(3), 275-292.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In Examining pedagogical content knowledge (pp. 95-132). Springer Netherlands.

Makgato, M., & Mji, A. (2006). Factors associated with high school learners' poor performance: a spotlight on mathematics and Physical Science. *South African Journal of Education*, 26(2):253-266.

Mansour, N. (2008). The Experiences and Personal Religious Beliefs of Egyptian Science Teachers as a Framework for Understanding the Shaping and Reshaping of their Beliefs and Practices about Science-Technology-Society (STS). *International Journal of Science Education*, 30(12):1605-1634.

Marek, E. A., & Methven, S. B. (1991). Effects of the learning cycle upon student and classroom teacher performance. *Journal of Research in Science Teaching*, 28(1): 41-53.

Maxwell, J. A. (2008). Designing a qualitative study. *The SAGE handbook of applied Social Research Method*s, 2: 214-253.

Mchunu, S. P. (2009). Challenges facing Physical Science educators in the implementation of the National Curriculum statement: the case of the Empangeni Education District. Unpublished Masters Dissertation, University of Zululand, Kwadlangezwa.

Mchunu, S. P. (2012). Alleviation of conceptual difficulties in grade 12 mechanics by addressing the challenges emanating from alternative conceptions. Unpublished Ph.D thesis, University of Zululand, Kwadlangezwa.

McLaughlin, M. W., &.Marsh, D. D. (1978). Staff development and school change. Teachers College Record, 80(1), 70-94.

McMillan, J. & Schumacher, S. (2006). Research in Education Evidence–Based Inquiry. Boston: Pearson Education.

Meyer, H. (2004). Novice and expert teachers' conceptions of learners' prior knowledge. *Science Education*, 88(6):970-983.

Meyer, T. (2002). Novice Teacher Learning Communities: An Alternative to One-on-One Mentoring. *American Secondary Education*, 31(1):27.

Milner, A. R., Templin, M. A., & Czerniak, C. M. (2011). Elementary science students' motivation and learning strategy use: Constructivist classroom contextual factors in a life science laboratory and a traditional classroom. *Journal of Science Teacher Education,* 22(2):151-170.

Morgan, C., & Xu, G. R. (2011). Reconceptualising obstacles to teacher implementation of curriculum reform: beyond beliefs. In Mathematics Education and Contemporary Theory Conference. Manchester Metropolitan University, UK.

Mortimer, E.F. & Scott, P.H. (2003). Meaning making in secondary science classrooms. Maidenhead: Open University.

Mudau, A. V. (2016). The classroom practice diagnostic framework: A framework to diagnose teaching difficulties of a science topic. *Eurasia Journal of Mathematics, Science & Technology Education,* 12(11):2797-2815.

Mudau, A.V. (2013). Conceptual Framework for Analysing Teaching Difficulties in the Science Classroom. *Mediterranean Journal of Social Sciences*, 4(13):125.

Naidoo, P., & Lewin, K. M. (1998). Policy and planning of physical science education in South Africa: Myths and realities. Journal of research in science teaching, 35(7), 729-744.

Neumann, R. (2000). Communicating student evaluation of teaching results: rating interpretation guides (RIGs). *Assessment & Evaluation in Higher Education*, 25(2):121-134.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, 21(5):509-523.

Noels, K.A., Clement, R., & Pelletier, L.G. (1999). Perceptions of teacher's communicative style and student's intrinsic and extrinsic motivation. *The Modern Language Journal*, 83 (1):23-34.

Nola, R. (1997). Constructivism in science and science education: A philosophical critique. *Science and Education*, 6(1-2):55-83.

Norman, K. A., & Spencer, B. H. (2005). Our lives as writers: Examining preservice teachers' experiences and beliefs about the nature of writing and writing instruction. Teacher Education Quarterly, 32(1), 25-40.

Oliver, J.S., & Koballa, T. (1992, March). Science educators' use of the concept of belief. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Boston, Massachusetts.

Ono, Y., & Ferreira, J. (2010). A case study of continuing teacher professional development through lesson study in South Africa. South African Journal of Education, 30(1), 59-74.

Onwu, G. & Stoffels, N. (2005). Instructional Functions in large under-resourced science classes perspectives of South African teachers. *Perspectives in Education,* 23(3):79-71.

Pajares, F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62:307-332.

Pappano, L. (2007). More than "making nice". Getting teachers to (truly) collaborate. *Harvard Education Letter,* 23(2):1-4.

Park, S., Jang, J. Y., Chen, Y. C., & Jung, J. (2011). Is pedagogical content knowledge (PCK) necessary for reformed science teaching?: Evidence from an empirical study. *Research in Science Education*, 41(2):245-260.

Peacock, A. (1993). The in-service training of primary school teachers in science in Namibia. *British Journal of In-Service Education,* 19:21-26.

Piaget J. (1952). The origins of intelligence in children. New York: International Universities Press.

Rammala, M. S. (2009). Factors contributing towards poor performance of grade 12 learners at Manoshi and
Mokwatedi High Schools, Unpublished Masters dissertation, University of Limpopo, Polokwane.

Ramnarain, U. (2013). The achievement goal orientation of disadvantaged Physical Sciences students from South Africa. *Journal of Baltic Science Education*, 12(2): 139-151.

Ramnarain, U. D. (2014). Teachers' perceptions of inquiry-based learning in urban, suburban, township and rural high schools: The context-specificity of science curriculum implementation in South Africa. *Teaching and Teacher Education*, 38:65-75.

Ramnarain, U., & Schuster, D. (2014). The pedagogical orientations of South African Physical Sciences teachers towards inquiry or direct instructional approaches. *Research in Science Education*, 44(4):627-650.

Reddy, K., Ankiewicz, P. J., & De Swardt, A. E. (2005). Learning theories: A conceptual framework for learning and instruction in technology education. *South African Journal of Higher Education*, 19(3):14-34.

Redish, E. F., Saul, J. M., & Steinberg, R. N. (2000). Student expectations in introductory physics.

Richardson, V. (1996). The roles of attitude and beliefs in learning to teach. Retrieved from: https://www.researchgate.net/publication/239666513. Accessed [28 October 2017].

Rogan, J. M., & Grayson, D. J. (2003). Towards a theory of curriculum implementation with particular reference to science education in developing countries. *International Journal of Science Education*, 25:1171–1204.

Rogan, J., & Aldous, C. (2005). Relationships between the constructs of a theory of curriculum implementation. *Journal of Research in Science Teaching*, 42(3):313-336.

Ryan, R. M., Connell, J. P., & Deci, E. L. (1985). A motivational analysis of self-determination and self-regulation in education. Research on motivation in education: The classroom milieu, 2, 13-51.

Saiduddin, J. (2003). Factors Affecting Achievement at Junior High School on the Pine Ridge Reservation. Unpublished Ph.D dissertation, Ohio State University, Ohio.

Sayed, Y., Subrahmanian, R., Soudien, C., Carrim, N., Balgopalan, S., Nekhwevha, F., & Samuel, M. (2007). Education exclusion and inclusion: Policy and implementation in South Africa and India. DFID Researching the Issues, 72.

Schwartz, R., & Lederman, N. (2008). What scientists say: Scientists' views of nature of science and relation to science context. International *Journal of Science Education*, 30(6):727-771.

Seaberg, J. R. (1998). Utilizing sampling procedures. *Social Work Research and Evaluation*, 3:240-257.

Seroto, J. (2004). The impact of South African legislation (1948-2004) on black education in rural areas: A historical perspective. Unpublished D.ED dissertation, University of South Africa, Pretoria.

Shavelson, R. J., & Stern, P. (1981). Research on teachers’ pedagogical thoughts, judgments, decisions, and behavior. Review of educational research, 51(4), 455-498.

She, H. C. (2000). The interplay of a biology teacher's beliefs, teaching practices and gender-based student-teacher classroom interaction. *Educational Research*, 42(1): 100-111.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational researcher, 15(2), 4-14.

Shulman, L. S. (1996). Paradigms and research programmes in the study of teaching: A contemporary perspective. In: Wittrock, M.C., Ed., Handbook of Research on Teaching, 3rd Edition, Macmillan, New York, 3-36.

Shulman, L.S. (1987). Knowledge and teaching: foundations of the new reform. *Harvard Educational Review*, 57(1):1-22.

Sinclair, M. (2007) Editorial: A guide to understanding theoretical and conceptual frameworks. *Evidence Based Midwifery,* 5(2):39.

Smylie, M.A., Bilcer, D.K., Greenberg, R.C., & Harris, R.L. (1998). Urban teacher professional development: A portrait of practice from Chicago. Paper presented at the annual meeting of the American Educational Research Association. April, 1998. San Diego, CA.

Staver, J. R. (2007). Teaching science. *International Academy of Education Series,*17(2007): 1-27.

Steyn, T. (2009). Teachers' perceptions of continuing professional development programmemes in South Africa: a qualitative study*. Acta Academica*, 41(4):113-137.

Supovitz, J.A., & Turner, H.M. (2000). The effects of professional development on science teaching practices and classroom culture. *Journal of Research in Science Teaching*, 37:963–980.

Trumper, R. (2006). Factors affecting junior high school students' interest in physics. Journal of Science Education and Technology, 15(1), 47-58.

Tsai, C. (2002). Nested epistemologies: science teachers’ beliefs of teaching, learning and science. *International Journal of Science Education,* 24(8):771-783.

Tschannen-Moran, M., Hoy, A.W., & Hoy, W.K. (1998). Teacher efficiency: It's meaning and measure. *Review of Educational Research*, 68(2): 202 -248.

Van der Poll, H. M., & Van der Poll, J. A. (2007). Towards an Analysis of Poor Learner Performance in a Theoretical Computer Literacy Course. In Proceedings of the 2007 Informing Science and IT Education Joint Conference (pp. 22-25).

van Driel, J.H., Verloop, N., de Vos, W. (1998). Developing Science Teachers' Pedagogical Content Knowledge. *Journal of Research in Science Teaching,* 35(6):673–695.

Villegas-Remers, E. (2003). Teacher professional development: An international view of the literature. Retrieved from: UNESCO website: http://unesdoc. Accessed [28 October 2017].

Wenglinsky, H. (2002). The link between teacher classroom practices and student academic performance*. Education Policy Analysis Archives*, 10(12):1-30.
Wood, F. H., & Thompson, S. R. (1980). Guidelines for better staff

Woolfolk, A. (2007). Educational Psychology. 10th ed. Pearson Education Inc.

Zakaria, E. & Daud, Y. (2009). Assessing mathematics teachers' professional development needs. *European Journal of Social Sciences*, 8(2):225-231.

APPENDICES

APPENDIX 1

Physical Sciences CAPS Requirements & Criteria

GRADE	NO. OF WEEKS ALLOCATED	CONTENT, CONCEPTS & SKILLS (WEEKS)	FORMAL ASSESSMENT (WEEKS)
10	40	30	10
11	40	30	10
12	40	29	11

Table 1a: Allocation of Teaching Time for Physical Sciences Grades 10, 11, 12 (DBE, p. 9, 2011)

2.4 OVERVIEW OF TOPICS

Topic	Content	
Mechanics	Grade 10	**Introduction to vectors & scalars; Motion in one dimension** (reference frame, position, displacement and distance , average speed, average velocity, acceleration, instantaneous velocity, instantaneous speed, description of motion in words, diagrams, graphs and equations.) **Energy** (gravitational potential energy, kinetic energy, mechanical energy, conservation of mechanical energy (in the absence of dissipative forces)) **30 hours**
	Grade 11	**Vectors in two dimensions** (resultant of perpendicular vectors, resolution of a vector into its parallel and perpendicular components), **Newton's Laws and Application of Newton's Laws** (Newton's first, second and third laws and Newton's law of universal gravitation, different kinds of forces: weight, normal force, frictional force, applied (push, pull), tension (strings or cables), force diagrams, free body diagrams and application of Newton's laws(equilibrium and non-equilibrium)) **27 hours**
	Grade 12	**Momentum and Impulse** (momentum, Newton's second law expressed in terms of momentum, conservation of momentum and elastic and inelastic collisions, Impulse), **Vertical projectile motion in one dimension (1D)** (vertical projectile motion represented in words, diagrams, equations and graphs), **Work, Energy & Power** (work , work-energy theorem, conservation of energy with non-conservative forces present, power) **28 hours**
Waves, Sound & Light	Grade 10	**Transverse pulses on a string or spring** (pulse, amplitude superposition of pulses), **Transverse waves** (wavelength, frequency, amplitude, period, wave speed, **Longitudinal waves** (on a spring, wavelength, frequency, amplitude, period, wave speed, sound waves), **Sound (**pitch, loudness, quality (tone), ultrasound), **Electromagnetic radiation** (dual (particle/wave) nature of electromagnetic (EM) radiation, nature of EM radiation, EM spectrum, nature of EM as particle - energy of a photon related to frequency and wavelength) **16 hours**
	Grade 11	**Geometrical Optics** (Refraction, Snell's Law, Critical angles and total internal reflection), **2D & 3D Wave fronts** (Diffraction) **13 hours**
	Grade 12	**Doppler Effect (either moving source or moving observer)** (with sound and ultrasound, with light - red shifts in the universe.) **6 hours**
Electricity & Magnetism	Grade 10	**Magnetism** (magnetic field of permanent magnets, poles of permanent magnets, attraction and repulsion, magnetic field lines, earth's magnetic field, compass), **Electrostatics** (two kinds of charge, force exerted by charges on each other (descriptive), attraction between charged and uncharged objects (polarisation), charge conservation, charge quantization),**Electric circuits_** (emf, potential difference (pd), current, measurement of voltage (pd) and current, resistance, resistors in parallel) **14 hours**
	Grade 11	**Electrostatics** (Coulomb's Law, Electric field), **Electromagnetism** (Magnetic field associated with current-carrying wires, Faraday's Law), **Electric circuits** (Energy, Power) **20 hours**
	Grade 12	**Electric circuits** (internal resistance and series-parallel networks), **Electrodynamics** (electrical machines (generators, motors), alternating current) **12 hours**
Matter & Materials	Grade 10	**Revise matter and classification** (materials; heterogeneous and homogeneous mixtures; pure substances; names and formulas; metals and non-metals; electrical and thermal conductors and insulators; magnetic and nonmagnetic materials). **States of matter and the kinetic molecular theory**. **Atomic structure** (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantization and electron configuration). **Periodic table** (position of the elements; similarities in chemical properties in groups, electron configuration in groups). **Chemical bonding** (covalent bonding; ionic bonding; metallic bonding). **Particles substances are made of** (atoms and compounds; molecular substances and ionic substances). **28 hours**
	Grade 11	**Molecular structure** (a chemical bond; molecular shape; electronegativity and bond polarity; bond energy and bond length). **Intermolecular forces** (chemical bonds revised; types of intermolecular forces; states of matter; density; kinetic energy; temperature; three phases of water (macroscopic properties related to sub-microscopic structure)). **Ideal gases** (motion and kinetic theory of gases; gas laws; relationship between T and P) **24 hours**
	Grade 12	**Optical phenomena and properties of materials** (photo-electric effect, emission and absorption spectra) (**6 hours for physics) Organic chemistry** (functional groups; saturated and unsaturated structures; isomers; naming and formulae; physical properties; chemical reactions (substitution, addition and elimination). **Organic macromolecules** (plastics and polymers) **16 hours**

Topic		Content
Chemical Systems	Grade 10	**Hydrosphere 8 hours**
	Grade 11	**Lithosphere** (mining; energy resources) **8 hours**
	Grade 12	**Chemical industry** (fertilizer industry). **6 hours**
Chemical Change	Grade 10	**Physical and chemical change** (separation by physical means; separation by chemical means; conservation of atoms and mass; law of constant composition).**Representing chemical change** (balanced chemical equations). **Reactions in aqueous solution** (ions in aqueous solutions; ion interaction; electrolytes; conductivity; precipitation; chemical reaction types) **Stoichiometry (**mole concept**). 20 hours**
	Grade 11	**Stoichiometry** (molar volume of gases; concentration; limiting reagents; volume relationships in gaseous reactions) **Energy and chemical change** (energy changes related to bond energy; exothermic and endothermic reactions; activation energy). **Types of reactions** (acid-base; redox reactions; oxidation numbers **28 hours**
	Grade 12	**Reaction rate** (factors affecting rate; measuring rate; mechanism of reaction and of catalysis). **Chemical equilibrium** (factors affecting equilibrium; equilibrium constant; application of equilibrium principles). **Acids and bases** (reactions; titrations, pH, salt hydrolysis). **Electrochemical reactions** (electrolytic and galvanic cells; relation of current and potential to rate and equilibrium; standard electrode potentials; oxidation and reduction half reaction and cell reactions; oxidation numbers; application of redox reactions). **28 hours**
Skills for practical investigations	Grade 12	Skills for practical investigations in physics and chemistry. **4 hours**

Table 1b: Content Coverage for Physical Sciences Grades 10, 11, 12 (DBE, 2011)

GRADE 10								
Paper	Content	Marks	Total Marks/ Paper	Duration (Hours)	Weighting of Questions Across Cognitive Levels			
					Level 1	Level 2	Level 3	Level 4
PAPER1: *PHYSICS FOCUS*	Mechanics	75	150	2	15 %	35 %	40 %	10 %
	Waves, Sound & Light	40						
	Electricity & Magnetism	35						
PAPER 2: *CHEMISTRY FOCUS*	Chemical Change	60	150	2	15 %	40 %	35 %	10 %
	Chemical Systems	20						
	Matter & Materials	70						

Table 1c: Weighting of Content and Specification of weighting of questions for Grades 10 Final Exam (DBE, 2011)

COGNITIVE LEVEL	DESCRIPTION	PAPER 1 (PHYSICS)	PAPER 2 (CHEMISTRY)
1	Recall	15 %	15 %
2	Comprehension	35 %	40 %
3	Analysis, Application	40 %	35 %
4	Evaluation, Synthesis	10 %	10 %

Table 1d: Weighting of Cognitive Levels for Examinations and Control Tests. (DBE, 2011)

APPENDIX 2

SCHOOL SELECTION CRITERIA FORM QUESTIONNAIRE

Research Study

Dear Physical Science Educator,

Please fill in the details below, to determine if you meet the requirements of this research study. The participants of this study together with the identity of their school and learners will remain ***strictly anonymous***.

Only complete this application if your school is located within **a 15 km radius** of the District office.

Section A: Tick the appropriate column.

Criteria	**YES**	**NO**
1. Do you as a Physical Science teacher consent to be a part of this research study?		
2. Are you in possession of a teaching qualification?		
3. Are you in possession of an academic qualification in you field of specialisation?		
4. Are you a permanent staff member at your school?		
5. Do you foresee yourself leaving the school within the next year?		
6. Are you teaching grade ten in the academic year 2016?		

Section B: Tick the appropriate column.

School Performance	< 60 % (below average)	60%-79% (average)	80%-100% (above average)
1. Indicate your schools performance in the 2015 National Senior Certificate exam for Physical Sciences.			

Section C:

1. Please decide on a Pseudo name for your school: ____________.

Section D:

Complete this section ONLY if you as the teacher consent to be a part of this research.

This questionnaire seeks information on the **Physical Science teacher in the FET classroom**. The data gathered from this questionnaire is for research purposes only. All respondents are to remain anonymous.

INSTRUCTION: Please circle the appropriate number on the questionnaire.
Section A: Personal details

1. Your gender:

Male	1
Female	2

2. Age Category of the teacher

21-31	1
32-45	2
45-50	3
60>	4

3. Post level of the teacher:

Level 1 - Teacher	1
Level 2 – Head of Department	2
Level 03 – Deputy Principal	3

Level 4 - Principal	4

4. Are you in possession of a qualification that warrants you to teach Physical Sciences? (E.g. specialisation in Physical Sciences at a tertiary level)

Yes	1
No	2

5. Years of teaching experience (teaching Physical Sciences)

< 2	1
3-5	2
6-9	3
10 >	4

6. Years of teaching experience, with grade ten Physical Sciences under CAPS

< 1	1
1-2	2
2-3	3
> 3	4

7. Years of teaching experience in the FET phase

< 1	1
2-4	2
5-8	3
9 >	4

8. Geographical area of school

Urban/Semi-urban	1
Rural	2

APPENDIX 3

DISTRICT CONSENT

__/__/2016

RE: REQUESTING PERMISSION TO CONDUCT RESEARCH AT HIGH SCHOOLS IN THE ______ DISTRICT

Research Title: EXPLORING THE EXPERIENCES OF TEACHERS IN THE IMPLENTATION OF THE PHYSICAL SCIENCES CURRICULUM IN A GRADE TEN CLASS IN THE PROVINCE OF KWA-ZULUNATAL

Researcher: T Dhurumraj _ 4348 616 9

Supervisor: Prof A.V Mudau

UNISA: Department of Science and Technology Education

Email: mudauav@unisa.ac.za

Attention: District Director - _______ District

Dear Sir/Madam,

I, Thasmai Dhurumraj am a DEd student at the University of South Africa. I am conducting a research study with the Department of Science and Technology Education towards the completion of my DEd study at the University.

The aim/s of the study is to:

- Explore the experiences of teachers in implementing the Physical Science curriculum in grade ten.
- Determine how the teacher's knowledge of the subject, learners and context influence his/her classroom practice.
- Determine how professional development impacts on the type of instruction the teacher uses in the classroom.
- Determine how the teacher's beliefs about teaching influences his/her use of instruction in the classroom.

The study will entail observations of educator/s in practice, interviews (which will be conducted during the educators free time), as well as the answering of questionnaires by educator.

The benefit/s of this study is that it would help to greatly reduce the gap that exists between curriculum theory and curriculum practice for the subject Physical Science. The grade ten syllabus for Physical Sciences is rather lengthy. Completion of this syllabus is very difficult from my own experience as a teacher.

Because grade 10 lays the foundation for Physical Sciences it can be deemed the most crucial academic year for a learner doing the subject. A poor foundation at grade 10 ultimately impacts on the learners' performance at grade 11 and subsequently grade 12. Therefore if the experiences of teachers can be better understood then the education departments can implement intervention and developmental workshops that are structured according to the needs of the teachers. This would then help to improve the implementation of the curriculum. By drawing on the experiences of teachers, the instructional strategies used by different individuals to facilitate effective teaching and learning can be incorporated into staff development workshops as teaching aid for teachers that experience difficulties.

Potential risk/s of this study may be educators dropping out of the study.

Feedback to the respective schools will follow in the form of a written report, by the researcher at the end of the study.

Participation in this study is voluntary and involves no feasible risks or harm. All respondents and schools in this study will remain anonymous. This study will in no way interfere with or disrupt the daily teaching of learners and all interviews with teachers will be conducted during non-teaching time.

Yours sincerely

Thasmai Dhurumraj

(Researcher)

Email: thasmai@hotmail.com

Contact: 061 413 2514

APPENDIX 4

SCHOOL CONSENT

__/__/2016

RE: REQUESTING PERMISSION TO CONDUCT RESEARCH AT YOUR INSTITUTE

Research Title: EXPLORING THE EXPERIENCES OF TEACHERS IN THE IMPLENTATION OF THE PHYSICAL SCIENCES CURRICULUM IN A GRADE TEN CLASS IN THE PROVINCE OF KWA-ZULUNATAL.

Researcher: T Dhurumraj _ 4348 616 9

Supervisor: Prof A.V Mudau

UNISA: College of Maths, Science and Technology

Email: mudauav@unisa.ac.za

Tel: 012- 429 6353

Dear Sir/Madam,

I, Thasmai Dhurumraj am conducting a research study with the Department of Maths, Science and Technology Education towards the completion of a D Ed study at the University of South Africa.

The aim/s of the study is to:

- Explore the experiences of teachers in implementing the Physical Science curriculum in grade ten.
- Determine how the teacher's knowledge of the subject, learners and context influence his/her classroom practice.
- Determine how professional development impacts on the type of instruction the teacher uses in the classroom.
- Determine how the teachers' beliefs about teaching influences his/her use of instruction in the classroom.

The study will entail a total of five observations of educator/s in practice, interviews (which will be conducted during the educators free time), as well as the answering of questionnaires by educator.

The benefit/s of this study is that it would help to greatly reduce the gap that exists between curriculum theory and curriculum practice for the subject Physical Science. The grade ten syllabus for Physical Sciences is rather lengthy. Completion of this syllabus is very difficult from my own experience as a teacher.

Because grade 10 lays the foundation for Physical Sciences it can be deemed the most crucial academic year for a learner doing the subject. A poor foundation at grade 10 ultimately impacts on the learners' performance at grade 11 and subsequently grade 12. Therefore if the experiences of teachers can be better understood then the education departments can implement intervention and developmental workshops that are structured according to the needs of the teachers. This would then help to improve the implementation of the curriculum. By drawing on the experiences of teachers, the instructional strategies used by different individuals to facilitate effective teaching and learning can be incorporated into staff development workshops as teaching aid for teachers that experience difficulties.

Potential risk/s of this study may be educators dropping out of the study.

Feedback to the respective schools will follow in the form of a written report, by the researcher at the end of the study.

All respondents and schools in this study will remain anonymous.

Yours sincerely

Thasmai Dhurumraj

(Researcher)

Email: thasmai@hotmail.com

Contact: 061 413 2514

Consent Granted/Not Granted: ________________ Date: __________

School Principal Signature______________________

APPENDIX 5

GUIDELINE FOR ANALYSIS OF INQUIRY APPROACH AND SKILLS DEVELOPMENT DURING OBSERVATION OF PRACTICAL LESSON

(The rubric below developed from an adaptation and modification of the PSI-S instrument of Campbell et al. (2010))

The Analytic tool below allows the researcher to analyse if the instructional strategies used by the teacher during practical lessons promotes the development of scientific skills such as inquiry. The rating codes used are as follows:

0 – Never occurred
1 – Occasionally occurred
2 – Always occurred

CRITERIA	RATING CODE	ADDITIONAL COMMENT
A. Asking research questions in a Physical Science Class		
A1. The teacher formulates questions which can be answered by the research.		
A2. The teacher is of the belief that allowing learners to structure their own research questions is important.		
A3. Time is given to refining the teachers research questions so that they can be answered by the investigation.		
B. Designing Practical Investigations		
B1. Teacher gives step-by-step instructions before learners conduct investigations		
B2. Teacher designs the methodology for learner investigations		
B3. Teacher allows learners to engage in the critical assessment of the procedures that are employed when they conduct investigations		
B4. Teacher allows learners to justify the appropriateness of the procedures that are employed when they conduct investigations		

C. Conducting Physical Science Practical Investigations		
C1. Teacher conducts procedures of an investigation before the learners		
C2. The investigation is conducted by the teacher in front of the class i.e. demonstration lesson		
C3. Teacher allows learners to actively participate in investigations as they then conduct them		
C4. Teacher believes each learner has a role as investigations are conducted		
D. Data Collecting for a Practical Investigation		
D1. Teacher informs learners to take detailed notes during each investigation along with other data they collect		
D2. Teacher ensures learners understand why the data they are collecting are important		
D3. Teacher allows learners to decide when data should be collected in an investigation		
E. Drawing conclusions		
E1. Teacher allows learners to develop their own conclusions for investigations		
E2. Teacher gives allowance for learners to consider a variety of ways of interpreting evidence when making conclusions		
E3. Teacher gives room for learners to connect conclusions to scientific knowledge		
E4. Teacher allows learners to justify their conclusions		

APPENDIX 6

OBSERVATION NUMBER:………………..SCHOOL:……………………………….

TEACHER:……………………………………SECTION:……………………….........

END TIME:………………………………….. START TIME:……………..........………

DATE:…………………………

CATEGORY – TEACHER KNOWLEDGE					
Lesson Presentation	**Methodology/ Approach**	**Teacher Knowledge (content, context, learners)**	**Interactions with learners**	**Types of activities used**	**Use of Resources**

APPENDIX 7
TEACHER INTERVIEW 01:

1. Briefly describe your school in terms of the learners and staff?

2. What is the medium of instruction at your school?

3. How many Physical Science teachers are there at your school that actually teach the subject?

4. Does the school have a functional Physical Science Laboratory?

5. How many lessons are there in a week for Physical Sciences for each grade?

6. What is the duration of each lesson?

7. At your school do the learners move from one class to another for lessons?

8. Are your lessons held in a classroom or in the Physical Science laboratory?

9. What kind of teaching aids do you use for your lessons?

10. Do you also teach Natural Sciences?

11. Do all learners have access to a text book?

12. As the teacher do you feel that you are equipped (in terms of teaching aid/s) to deliver the curriculum efficiently?

13. What would you describe as your greatest challenge in terms of implementing the curriculum?

APPENDIX 8

TEACHER INTERVIEW: 02

1. Please describe your teaching experience as a Physical Science teacher in terms of the following:
   - Number of years teaching Physical Science
   - Number and type of schools you taught at
   - The grades you taught Physical Science to

2. How often do you take the same class from grade 10 into grade 11 and into grade 12?

3. What are your experiences when this is done?

4. Describe your educational background from the time you have matriculated to date.

5. What in your opinion is the best way to learn Physical Sciences?

6. What motivates you as a teacher to continue teaching?

7. What frustrates you the most about teaching?

8. What do you understand by the term “inquiry teaching” for Physical Sciences?

9. Do you teach Physical Sciences using the inquiry approach?

10. Do you think the inquiry approach is a good or appropriate method for teaching Physical Science in a South African classroom? Provide an explanation for your response.

APPENDIX 9

TEACHER QUESTIONNAIRES 01:

1. What inspired you to teach Physical Sciences?

2. How would you describe your classroom/laboratory and why?

3. What do you consider to be the founding principles of teaching Physical Sciences?

4. How would you describe your teaching style for Physical Science?

5. How do you determine what type of instruction you will use when teaching a concept to your learners?

6. How do you know when your learners have understood your lesson?

7. How do you as a teacher picture a good learner in Physical Sciences?

8. What characteristics of a learner leads you to believe that he/she is a good learner?

9. How do you structure your lessons when teaching Physical Science?

10. Do you think teaching Physical Science can be done in the same manner as subjects like history and business studies are taught?

11. As a teacher how do you decide what to teach and what not to teach, as well as the depth at which you should be teaching a section?

12. How do you decide when to move from one concept to another?

13. Describe the best teaching situation that you have ever experienced as a Physical Science teacher or learner.

14. In what way do you try to model that best teaching/learning situation in your classroom?

15. How do you as the teacher maximise your teaching environment so that is most conducive to learning?

TEACHER QUESTIONNAIRE: 02

1. What do you feel as a teacher hinders you, in your performance to teach?

2. How have you as a teacher attempted to remove/address the obstacles mentioned above?

3. Is there anything at the school level that influences the way you teach?

4. Do you have visits from your subject advisor? If yes how often does this happen?

5. What do you understand by professional development?

6. How often in one academic would you say you have engaged in professional development?

7. Does any of the professional development workshops you attend focus on grade ten Physical Science content?

8. Would you say that you are well trained in the content of the grade ten syllabus?

9. As a teacher of Physical Science what kind of professional development would you like to engage in?

10. Do you think professional development would help improve your knowledge of teaching? Please elaborate on your response.

11. If you had to tailor a professional development programme me how and what would you include for it to be most beneficial to teachers of Physical Sciences.

TEACHER QUESTIONNAIRE: 03

1. What in your teaching environment influences the way you teach Physical Sciences?

2. What skills do you want your learners to achieve at the end of grade ten Physical Sciences?

3. How would you describe the cognitive level of your grade 10 learners?

4. What measures as a teacher do you adopt to cater for learners with varying cognitive levels in your class?

5. Do all your learners complete homework and classwork on time?

6. How do you mark classwork and homework activities?

7. Do you often do experiments with your learners?

8. Are the learners given the chance to conduct the experiments themselves? If yes/no provide detailed reasons for your response.

9. In terms of learning material, what do learners use?

10. Does the attitude of the leaners influence the way you structure your lessons? If yes, please explain.

APPENDIX 10

ANNUAL TEACHING PLAN 2017 GRADE TEN

Recommended Annual Teaching Plan for Physical Sciences Grade 10: 2017

Week	Week Ending	Knowledge Area	Concepts for week	Page in CAPS doc	Date completed	HOD Sig
			TERM 1			
1	13/01	MATTER AND MATERIALS	**Revise Matter & classification (from grade 9)** • The material(s) of which an object is composed • Mixtures: heterogeneous and homogeneous. • Pure substances: elements and compounds. • Names and formulae of substances. • Metals, metalloids and non-metals • Electrical conductors, semiconductors and insulators	15 – 19	20. 01. 2017.	
2	20/01		• Thermal conductors and Insulators • Magnetic and nonmagnetic materials. **States of Matter and the Kinetic Molecular Theory** • Three states of matter • Kinetic Molecular Theory **Prescribed Experiment:** (Formal) Heating and cooling curve for water.	19	23. 01. 2017.	
3	27/01		**Periodic Table** • The position of the elements in the periodic table related to their electronic arrangements • Similarities in chemical properties among elements in Groups 1, 2, 17 and 18 **The Atom:** **basic building block of all matter (Atomic structure)** • Models of the atom. • Atomic mass and diameter. • Structure of the atom: protons, neutrons, electrons. • Isotope • Electron configuration. **Recommended Experiment** (Informal): Do flame tests to identify some metal cations and metals (Informal)	20 – 24 2017.01.27		
4	03/02		**Chemical Bonding** Covalent; Ionic and Metallic bonding	25 03.02.2017.		
5	10/02		**Particles substances are made of** Atoms and compounds. • Molecules (molecular substances) are due to covalent bonding. • Ionic substances are due to ionic bonding. (The EFFECT of the different types of chemical bonding are emphasized here.)	32 - 34 10.02.2017 17.02.2017		
6	17/02		**Transverse pulses on a string or spring** • Pulse, amplitude • Superposition of Pulses **Recommended Experiment** (Informal): Use a ripple tank to demonstrate constructive and destructive interference of two pulses.	26 24.02.2017.		
7	24/02	WAVES, SOUND AND LIGHT	**Transverse waves** • Wavelength, frequency, amplitude, period, wave speed **Longitudinal waves:** • On a spring • Wavelength, frequency, amplitude, period, wave speed.	27 – 28 03.03.2017.		
8	03/03		**Sound** • Sound waves	28 – 29		

2

			Practical Demonstration: (Informal) How to make sound using a vuvuzela, string, tuning-fork, loud-speaker, drum-head • Pitch, loudness, quality (tone) • Ultrasound			
9	10/03		**Electromagnetic Radiation** • Dual (particle/wave) nature of EM radiation • Nature of EM radiation • EM spectrum • Nature of EM as particle - energy of a photon related to frequency and Wavelength **Waves, legends and folklores** • Detection of waves associated with natural disasters	29 - 31		
10	17/03	**ASSESSMENT**				
11	24/03	HOLIDAY				
12	31/03	Notes, Reflections and comments: Term 1				

APPENDIX 11

DATA ANALYSIS SCHEME

THEME: TEACHER KNOWLEDGE		
Teacher Knowledge is defined as the source that influences every action of the teacher it includes an understanding of the content, the context and the learners. The subject content knowledge of the teacher is further divided into common knowledge of content – this is described as the everyday knowledge, specialized knowledge of content – this refers to the knowledge gained through professional training and classroom experience, and the third aspect is knowledge of content and learners. It is the teachers knowledge that enables the teacher to decide on instructional strategies to be used in the classroom (Ball and Bass, 2002; Mudau, 2016). This study places emphasis on the teacher's content knowledge, contextual knowledge and the teacher's knowledge of his/her learners learning in a South African classroom. *Research Question: How does the teacher's knowledge influence his/her classroom practice in the grade ten class?*		
Category: Content knowledge *Definition: A broad and in-depth understanding of the subject matter or topic to be taught. This includes both abstract knowledge, such as knowledge of discipline conceptual structures, and more specific knowledge, such as knowledge of details of a particular topic (Hashweh, 1987).*	**Category: Context knowledge** *Definition: Context knowledge is the teachers understanding of the classroom in which he/she practises his/her teaching skills. It includes all the contextual aspects that could influence the teaching of the subject matter such as resources, socio-economic background and the curriculum (Mudau, 2016).*	**Category: Understanding of Learner's Learning** *Definition: The teacher's understanding of his/her learners and understanding the needs of his/her learners towards learning; their cognitive levels and their abilities to apply the knowledge; their misconceptions and topics they perceive as being difficult; and their prior knowledge that they have gained from grade nine of concepts in Physical Sciences (Mudau, 2016; Magnusson et al. 1999).*
Subject Matter Knowledge (SMK) :Elements, compounds, atoms, relative atomic mass, isotopes, ions, anions, cations, molecules, states of matter, KMT, electrons, nucleons, protons, nucleons	Learner Discipline, socio-economic status of learners, resources, extensive syllabus	Prior knowledge, learners' skills and abilities, learner difficulties, mathematical knowledge, learner apathy, learner cognition

THEME: Teacher Beliefs

Teacher Beliefs is defined as the attitudes, thoughts, judgments and prior decisions of teachers that influence their classroom practices and also the teachers teaching performance (Shavelson and Stern, 1981; Clark and Peterson, 1986)

Research Question: What are teacher's beliefs about teaching Physical Sciences in grade ten?

Category: Teaching & Learning of Physical Sciences

Definition: The manner in which the teacher believes the teaching and learning of Physical Sciences in grade ten should take place in a South African Classroom

Teacher Epistemological Views of Physical Sciences (TEV):

Traditional view Teaching (transferring knowledge): facts, firm answers, clear definitions, accurate explanations

Traditional view Learning (reproducing knowledge from reliable sources): transferring of knowledge; memorization of formulae and facts, copying exactly what the teacher does; hard work on the same time of problems; passive learning,

Process view Teaching (places emphasis on scientific and mathematical procedure): teaching scientific methods, following problem solving procedures,

Process view Learning (pay attention to the processes of science and problem-solving procedures): learning through self-discovery.

Constructivist view Teaching (is done by allowing learners the opportunity to build on their prior knowledge): group work, building on prior knowledge, providing authentic tasks, inquiry learning

Constructivist view Learning (done through building personal understanding): interpretation data; exploring authentic experiences; engaging in class discussions; relating science to society and the environment and daily life.

THEME: Professional Development

For this study Profession Development is defined as the continuous process of equipping both experienced and novice teachers with the knowledge and skills they require to effectively and efficiently deliver the grade ten Physical Science curriculum in a South African classroom. Knowledge includes subject matter knowledge, knowledge of different instructional strategies, the ability to conduct scientific investigation, and common errors made by learners.

Research Question: What is the nature of the support system in terms of professional development to teachers on the implementation of the Physical Science curriculum in grade ten?

Category: Developmental Workshops for Grade 10

Definition: Continuous programmemes for teachers that builds on their content knowledge, scientific skills and promotes teacher change through the use of effective instructional models together with technology.
Teacher Content Training Programmes (TCTP): to strengthen subject matter expertise and pedagogical content knowledge.
Teacher Practical Training Programmes (TPTP): providing teachers the opportunity to conduct prescribed experiments under trained supervision

Peer Interaction (PI): at the school level teachers should be able to work with colleagues who teach the same subject in order to help strengthen their skills and build on their content knowledge and pedagogical knowledge.
Teaching Approaches (TA): Constructivist, cooperative, inquiry, lecturing.

APPENDIX 12

MS AVOS: TEACHER QUESTIONNAIRE RESPONSE

12. As the teacher do you feel that you are equipped (in terms of teaching aid/s) to deliver the curriculum efficiently?

Gr 12 almost. Gr 10 not at all. The prac's like heating and cooling curve I don't have a proper bunsen burner or 1 that works. The circuit prac still confuses me. The principal helps with grade 12 but not 10 plus there is no 1 else that can assit and we don't have gr 10 prac workshops. So I try my best to make do pracs are more investigative I give results and ask the learners to interprete it.

13. What would you describe as your greatest challenge in terms of implementing the curriculum?

Gr 10, it is 1 pracs. There was no w/shop. By June 3 quarter of the work must be done. The (L) are over whelmed by physics. It's their first year and some of the terms are like greek for them. Also mechanics which is so difficult is left for term 3 and 4 which are very short terms. and we rush through it and over the last 3 years that section is the worst performed. I don't have time myself to get back and do revision cos its exams and 1 syllabus is too long in gr 10.

Teacher Interview Questions 02 (1st Follow up):

1. Please describe your teaching experience as a Physical Science teacher in terms of the following:
   - Number of years teaching physical science
   - Number and type of schools you taught at
   - The grades you taught physical science to

Nine years. I teach gr 10/11/12 and I take my learners up, primarily cos I am the only physics teacher in my school. This is the first school I came to.

12. As the teacher do you feel that you are equipped (in terms of teaching aid/s) to deliver the curriculum efficiently?

Gr 12 almost. Gr 10 not at all. The pracs like heating and cooling curve I don't have a proper bunsen burner or 1 that works. The circuit prac still confuses me. The principal helps with grade 12 but not 10 plus there is no 1 else that can assit and we don't have gr 10 prac workshops. So I try my best to make do pracs are more investigative I give results and ask the learners to interprete it.

13. What would you describe as your greatest challenge in terms of implementing the curriculum?

Gr 10, it is 1 pracs. There was no w/shop. By June 3 quarter of the work must be done. The (L) are over whelmed by physics. It's their first year and some of the terms are like greek for them. Also mechanics which is so difficult is left for term 3 and 4 which are very short terms. and we rush through it and over the last 3 years that section is the worst performed. I don't have time myself to get back and do revision cos its exams and 1 syllabus is too long in gr 10.

Teacher Interview Questions 02 (1st Follow up):

1. Please describe your teaching experience as a Physical Science teacher in terms of the following:
   - Number of years teaching physical science
   - Number and type of schools you taught at
   - The grades you taught physical science to

Nine years. I teach gr 10/11/12 and I take my learners up, primarily cos I am the only physics teacher in my school. This is the first school I came to.

APPENDIX 13

PHYSICAL SCIENCE ANNUAL TEACHING PLAN (ATP – 2017)

26	11/08 (4 days)	MECHANICS	**Vectors and scalars** • Introduction to vectors & scalars.	53		
27	18/08		**Motion in one dimension:** • Reference frame, position, displacement and distance. • Average speed, average velocity, acceleration	54 - 55		
28	25/08		**Instantaneous speed and velocity and the equations of motion.** • Instantaneous velocity, instantaneous speed, • Description of motion in words, diagrams, graphs and equations.	56 – 57		

7

			Suggested Project: (Formal) **Refer to PoA.** Roll a trolley down an inclined plane with a ticker tape attached to it and use the data to plot a position vs. time graph.			
29 30	01/09 08/09		**Energy:** • Gravitational potential Energy • Kinetic energy • Mechanical energy (E_M) Conservation of mechanical energy (in the absence of dissipative forces).	58 59		
31 32 33	15/09 22/09 29/09 (4 days)		ASSESSMENT			

APPENDIX 14

WORKSHOP SCHEDULE FOR 2017

To: Cluster Managers
Ward Managers
Principals of Secondary Schools
Grade 10, 11 & 12 Teachers

GRADE 10, 11 & 12 ORIENTATION WORKSHOPS FOR 2017

1. The above-mentioned workshops will take place to update teachers on matters from the examiners' reports, the scope of work for the testing programme(s), subject content and methodology, SBA requirements and revision strategies, etc. Teachers will also have the opportunity of indicating their needs so that advisors could arrange on-going support.
2. **VENUES, DATES AND TIMES**
   - The various venues, dates and times for the workshops are indicated on the attached schedules.
   - Workshops are scheduled to **start at 13:30**.
3. Ideally, all teachers currently teaching the relevant subject and grade in 2017 should attend. However, if schools cannot accede to this request then it is imperative for the HOD (who must be teaching the relevant subject and grade/s) or the teacher who co-ordinates the relevant subject must attend. In addition, it is incumbent on the SMT to ensure that information from the workshops is cascaded to the relevant teachers
4. Teachers that will be attending workshops should ensure that the necessary arrangements have been made for their teaching obligations to be fulfilled at school.
5. Teachers are required to carry their subject specific documents and refreshments.
6. Consult the relevant Subject Advisor for any further information – see attached list.
7. Please bring the contents of this circular to the attention of the **relevant teachers** and **School Management Teams**.

E N MAGWAZA
CES: TLS FET

B H NTULI
DIRECTOR

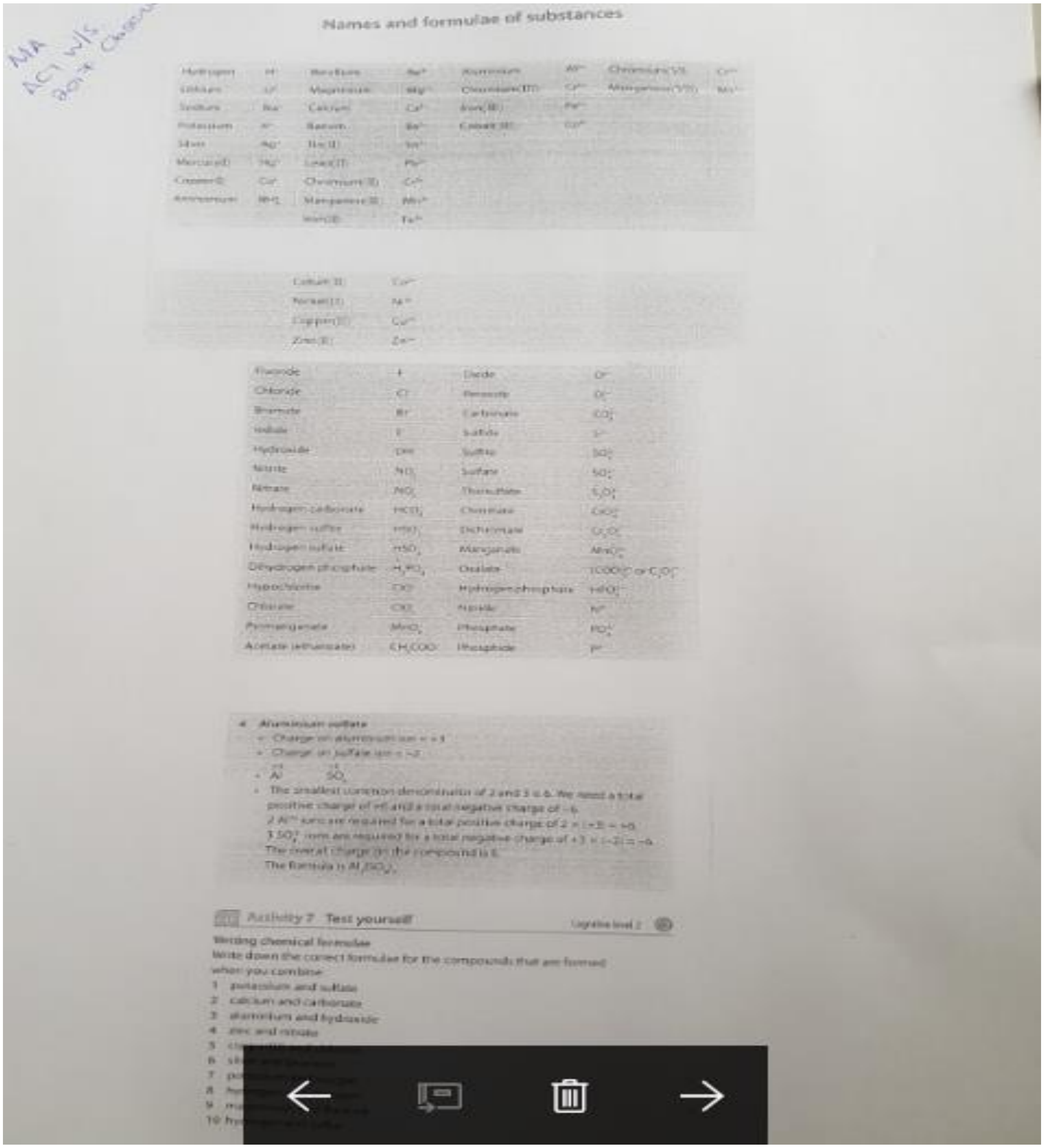
...Championing Quality Education - Creating and Securing a Brighter Fu

FET WORKSHOPS FOR 2017

SUBJECT	DURBAN CENTRAL	CHATSWORTH	PHUMELELA	UMBUMBULU
IsiZulu First Additional Language - Grade 12	31 January 2017 D E C	24 January 2017 C E C	26 January 2017 Kingsway High	26 January 2017 Kingsway High
IsiZulu First Additional Language, Grade 11	09 February 2017 D E C	06 February 2017 C E C	09 February 2017 L E C	09 February 2017 L E C
IsiZulu First Additional Language, Grade 10	20 February 2017 D E C	21 February 2017 C E C	23 February 2017 Kingsway	23 February 2017 Kingsway
IsiZulu First Additional Language - Gr 10,11,12	16 March 2016 – D E C Cluster Co-ordinators Only			
IsiZulu Home Language Orientation Grade 12	16 January 2017 L E C Group A, B &C		17 January 2017 L E C Umbumbulu, Chatsworth & Durban Central	
IsiZulu Home Language Orientation Grade 11	18 January 2017 L E C Group A, B & C		19 January 2017 L E C Umbumbulu,& Chatsworth & Durban Central	
IsiZulu Home Language Orientation Grade 10	18 January 2017 L E C Group A, B & C		19 January 2017 L E C Umbumbulu,& Chatsworth & Durban Central	
Life Orientation (LO) Grade 12	02 February 2017 D E C	07 February 2017 C E C	09 February 2017 L E C	31 January 2017 Amanzimtoti Library
Life Orientation (LO) Grade 10 & 11	23 February 2017 D E C	21 February 2017 C E C	14 February 2017 L E C	16 February 2017 Amanzimtoti Library
Life Orientation (LO) Cluster co-ordinators	14 March 2017 – L E C *Note: Cluster co-ordinators only*			
Life Sciences Grade 10, 11 & 12	01 February 2017 D E C	30 January 2017 C E C	31 January 2017 L E C	02 February 2017 L E C
Mathematics Orientation workshops	23 January 2017 D E C	24 January 2017 C E C	25 January 2017 L E C	26 January 2017 Kingsway HS
Mathematics Gr10, 11 & 12 CAPS	13 February 2017 D E C	14 February 2017 C E C	15 February 2017 L E C	16 February 2017 Kingsway HS
Maths Literacy Grade 10, 11 & 12	06 February 2017 D E C	07 February 2017 C E C	08 February 2017 L E C	09 February 2017 Kingsway HS
Mechanical Tech* Grade 10, 11 & 12	16 February 2017 C E C			
Music Orientation workshop Grade 10, 11 & 12	1 & 2 February 2017 Umlazi Senior Secondary			
Music - Content w/shop Grade 10, 11 & 12	22 & 23 February 2017 Umlazi Senior Secondary			
Physical Sciences Grade 10, 11 & 12	19 January 2017 Northwood HS	16 January 2017 Crossmoor Sec	17 January 2017 Ganges Sec	18 January 2017 Kingsway HS
Technical Maths Technical Science	To be advised			
Tourism Grade 10, 11 & 12	8 February 2017 D E C	03 February 2017 C E C	01 February 2017 L E C	09 Toti 2017 Amanzimtoti HS
Visual Arts Grade 10, 11 & 12	To be advised			

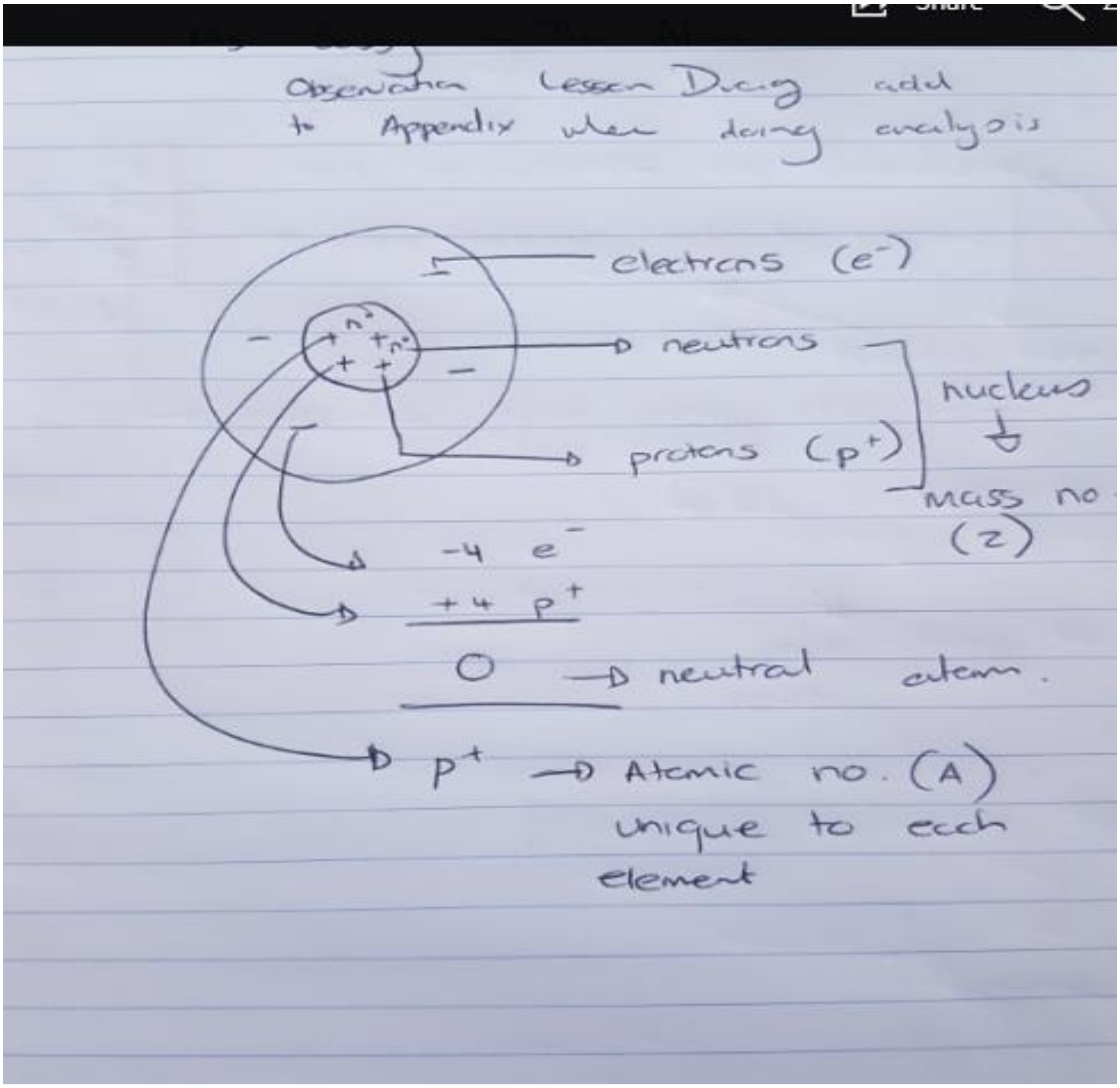
APPENDIX 15

MS AVOS WORKSHEET CHEMICAL FORMULAE



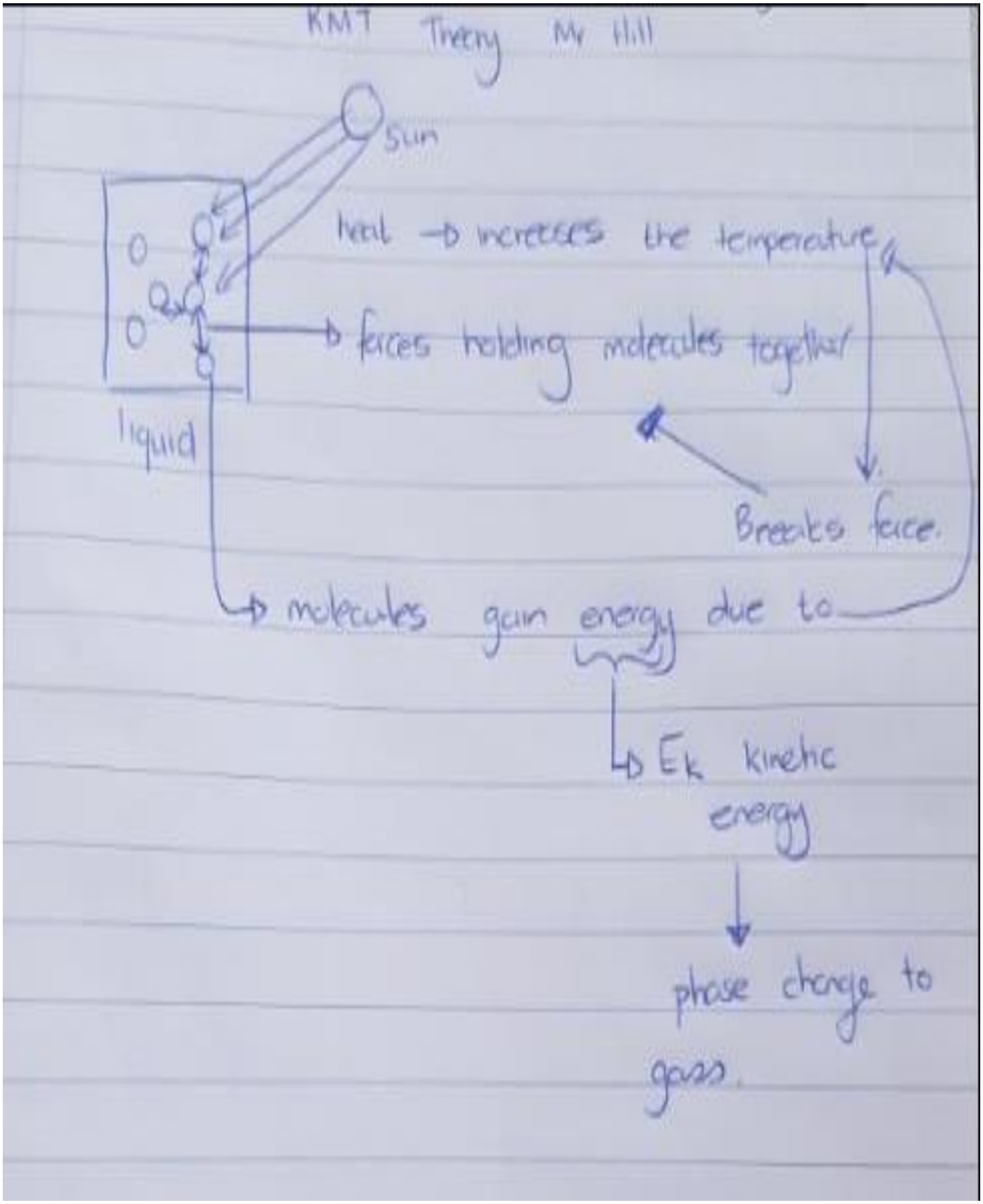
APPENDIX 16

MS SASSY ATOMIC STRUCTURE DRAWING



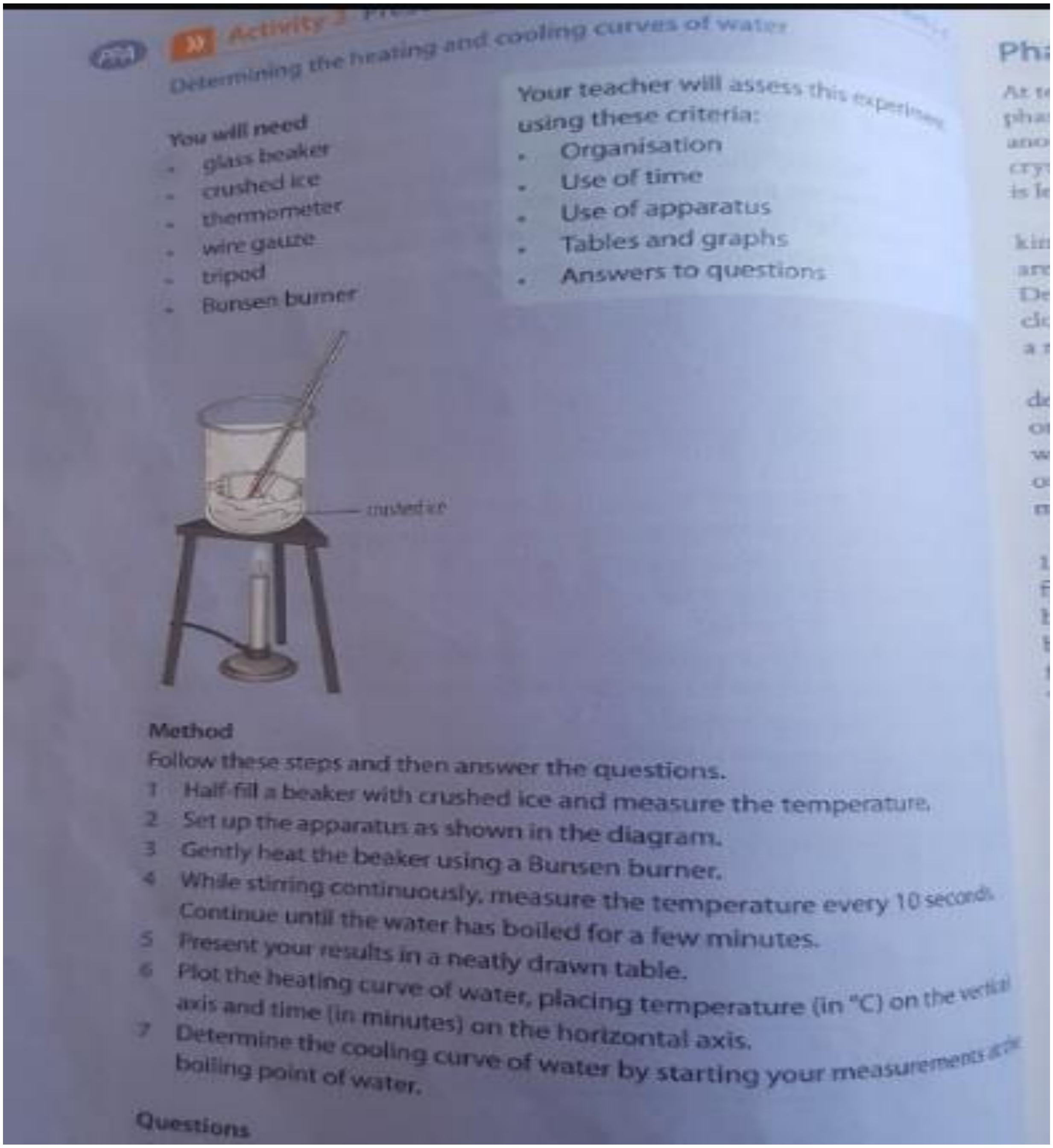
APPENDIX 17

MR HILL KMT SPIDER DIAGRAM



APPENDIX 18

PRESCRIBED HEATING AND COOLING CURVE PRAC IMAGE FROM TEXT



Activity 3

Determining the heating and cooling curves of water

You will need
- glass beaker
- crushed ice
- thermometer
- wire gauze
- tripod
- Bunsen burner

Your teacher will assess this experiment using these criteria:
- Organisation
- Use of time
- Use of apparatus
- Tables and graphs
- Answers to questions

Method

Follow these steps and then answer the questions.

1 Half-fill a beaker with crushed ice and measure the temperature.
2 Set up the apparatus as shown in the diagram.
3 Gently heat the beaker using a Bunsen burner.
4 While stirring continuously, measure the temperature every 10 seconds. Continue until the water has boiled for a few minutes.
5 Present your results in a neatly drawn table.
6 Plot the heating curve of water, placing temperature (in °C) on the vertical axis and time (in minutes) on the horizontal axis.
7 Determine the cooling curve of water by starting your measurements at the boiling point of water.

Questions

APPENDIX 19

Mr Hill PRAC WORKSHEET

GRADE 10: PRESCRIBED EXPERIMENT

Determining the heating and cooling curves of water

TOTAL: [illegible]

You will need
- glass beaker
- crushed ice
- thermometer
- wire gauze
- tripod
- Bunsen burner

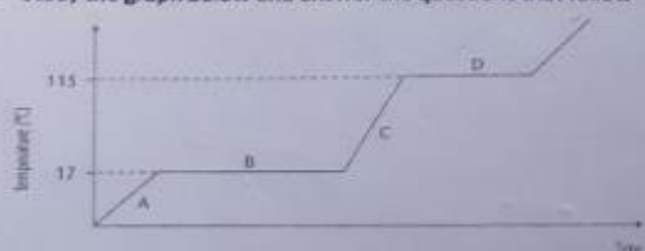
Method

Follow these steps and then answer the questions.

1 Half-fill a beaker with crushed ice and measure the temperature.
2 Set up the apparatus as shown in the diagram.
[illegible] Gently heat the beaker using a Bunsen burner.
[illegible] While stirring continuously, measure the temperature every 10 seconds. Continue until the water has boiled for a few minutes.
5 Present your results in a neatly drawn table.
6 Plot the heating curve of water, placing temperature (in °C) on the vertical axis and time (in minutes) on the horizontal axis. (5)
7 Determine the cooling curve of water by starting your measurements at the boiling point of water.

Questions

1. **At what temperature does heating not result in a temperature rise?** **(2)**
2. **What changes occur at these temperatures?** **(3)**
3. **Explain in your own words what happens when the water molecules are changing phase.** **(5)**
4. **Study the graph below and answer the questions that follow**



a) What physical state(s) is t[illegible]
b) What is the melting point[illegible]
c) What is the boiling point [illegible]
d) What happens to the tem[illegible]

APPENDIX 20

ETHICAL CLEARANCE

UNISA university of south africa

COLLEGE OF EDUCATION RESEARCH ETHICS REVIEW COMMITTEE

16 November 2016

Ref : **2016/11/16/43486169/51/MC**
Student : Ms T Dhurumraj
Student Number : 43486169

Dear Ms Dhurumraj,

Decision: Approved

Researcher: Miss T Dhurumraj
Tel: +2732 941 5258
Email: thamai@hotmail.com

Supervisor: Prof AV Mudau
College of Education
Department of Science and Technology of Education
Tel: +2712 429 6353
Email: mudauav@unisa.ac.za

Proposal: Exploring the experiences of teachers in the implementation of Physical Sciences curriculum in a Grade ten class

Qualification: D Ed in Curriculum and Instructional Studies

Thank you for the application for research ethics clearance by the College of Education Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the research.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the College of Education Research Ethics Review Committee on 16 November 2016.
The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the College of Education Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

Note:

The reference number **2016/11/16/43486169/51/MC** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the College of Education RERC.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof VI McKay
EXECUTIVE DEAN

APPENDIX 21

DISTRICT CLEARANCE

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma | Tel: 033 392 1041 | Ref.:2/4/8/1001

Miss T Dhurumraj
3 Coull Drive
La Mercy
Tongaat
4399

Dear Miss Dhurumraj

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"TEACHER EXPERIENCES WITH THE IMPLEMENTATION OF THE GRADE TEN PHYSICAL SCIENCE CURRICULUM AND ITS CASCADING IMPACT AT THE GRADE TWELVE LEVELS"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 November 2016 to 26 April 2018.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

uMlazi District

Dr. EV Nzama
Head of Department: Education
Date: 07 November 2016

APPENDIX 22

ACID AND BASES PROGRESSION

Table 3: Summary of Progression for Acid & Bases from Grade 10 - 12

Chemical Change	Grade 10	Grade 11	Grade 12
Duration	0.25 hours	6 hours	8 hours
Acid & Bases	Acid-base reactions - involve the transfer of protons. Explain the 4 types of reactions. Acid with metal, metal oxide, metal hydroxide and metal carbonate.	**Use the acid-base theories of, Arrhenius and Bronsted and Lowry to define acids and bases** • Define an acid as an H+ donor and a base as an H+ acceptor in reaction. • Identify conjugate acid/base pairs. • Define an ampholyte • List common acids (including hydrochloric acid, nitric acid, sulfuric acid and acetic acid) and common bases (including sodium carbonate, sodium hydrogen carbonate and sodium hydroxide) by name and formula. • Write the overall equation for simple acid-metal hydroxide, acid-metal oxide and acid -metal carbonate reactions and relate these to what happens at the macroscopic and microscopic level • •What is an indicator? Look for	**Explain what is meant by acids and bases?** • State acid and base models (Arrhenius, LowryBrønsted) • Write the reaction equations of aqueous solutions of acids and bases • Give conjugate acid-base pairs for given compounds. • Determine the approximate pH of salts in salt hydrolysis • Give the neutralisation reactions of common laboratory acids and bases. • How do indicators work? What is the range of methyl orange, bromo thymol blue and phenolphthalein indicators? • Do simple acid-base titrations • Do calculations based on titration reactions • Name some common strong and weak acids and bases • Explain the pH scale. • Calculate pH values of strong acids and strong bases • Define the concept of Kw.

		some natural indicators • •Use acid-base reactions to produce and isolate salts e.g.Na2SO4; CuSO4 and CaCO3	• Distinguish between strong and concentrated acids. • Distinguish between concentrated and dilute acids • Explain the auto-ionisation of water • Compare the Ka and Kb values of strong and weak acids and bases • Compare strong and weak acids by looking at (1) pH (2) conductivity (3) reaction rate • Look at the application of acids and bases in the Chlor-alkali industry (chemical reactions only) • Look at the application of acids and bases in the chemistry of hair. (What is the pH of hair? What is permanent waving lotion and how does it work? What are hair relaxers and how do they work? Discuss different ways of colouring hair

APPENDIX 23

TURNITIN REPORT

Doctoral Thesis Student 43486169

ORIGINALITY REPORT

19%	17%	9%	11%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	uir.unisa.ac.za Internet Source	2%
2	www.education.gov.za Internet Source	1%
3	uzspace.uzulu.ac.za Internet Source	1%
4	my.unisa.ac.za Internet Source	<1%
5	www.mcser.org Internet Source	<1%
6	www.saarmste.org Internet Source	<1%
7	Submitted to University of South Africa Student Paper	<1%
8	Washington T. Dudu. "Teachers' Practices of Inquiry When Teaching Investigations: A Case Study", Journal of Science Teacher Education, 03/27/2012 Publication	<1%

APPENDIX 24

EDITING CERTIFICATE

Vhutali Leadership and Management Institute

PO BoX 331
Louis Trichardt
0920

24 October 2017

Contacts: 27763881622 Email: drmafukata@gmail.com

Dear Sir/Madam

Re; Dissertation: **"Exploring the Experiences of Teachers in the Implementation of the Physical Sciences Curriculum in a Grade Ten Class"**

1. This serves to inform you that the above-mentioned dissertation has been edited and proofread by me. Dissertation details:

Candidate: THASMAI DHURUMRAJ
Student number: 4348- 616-9
University: University of South Africa
Degree: D.ED – WITH SPECIALISATION IN CURRICULUM STUDIES
Supervisor: Professor AV Mudau

2. This is to confirm that the dissertation in its current form is examinable

I hope you find this in order

Regards

Dr MA MAFUKATA

APPENDIX 25

Record of Observation Dates for Teachers 2017

Teacher	**Date**	**Date**	**Date**	**Date**	**Date**
Ms Avos	17/01	25/01	26/01	*	*
Ms Sassy	24/01	7/02	8/02	3/03	*
Mr Hill	21/01	28/02	7/03	*	*

***Most teachers were not prepared to do more than three interviews because they did not want to engage in follow up questions – due to time constraints.**